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THE UNIVERSITY OF ALBERTA

AN ECOLOGICAL STUDY OF THE BLACK-CROWNED NIGHT
HERON IN SOUTHERN ALBERTA

BY

JAMES WALKER WOLFORD

A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE DEGREE

OF MASTER OF SCIENCE

DEPARTMENT OF ZOOLOGY

EDMONTON, ALBERTA

APRIL, 1966

Thesis
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ABSTRACT

Black-crowned Night Herons (Nycticorax nycticorax) were studied in the Eastern Irrigation District of southern Alberta near Cassils, Tilley, and Rainier in 1964 and 1965.

Although the first Alberta record for Night Herons came in 1958, the exact year when the species invaded the province is unknown. Alberta Night Herons probably came from Saskatchewan.

Night Herons arrived in mid-April of 1964 and 1965 and commenced egg-laying in the last week of April. Nesting herons required large bodies of water with extensive beds of emergent vegetation. They nested well in from the prairie shore and preferred proximity to open water. It is thought that Ducks Unlimited impoundments, begun in 1938, provided suitable nesting habitat.

Nests were constructed mainly of emergent vegetation plus gumweed (Grindelia). Availability of emergents was important, bulrushes (Scirpus) being preferred over cattails (Typha). Generally the nests were poorly built, close to the water surface with little or no cup. Night Herons added materials to their nests throughout the nesting season.

Clutches ranged from one to eight eggs. Those over six were products of more than one female at each nest. Average initial clutch size varied from 3.2 to 4.1 eggs. Replacement clutches were smaller than initial clutches. The incubation period varied from 21 to 28 days, averaging 23.6 days.

Differences from year to year in nesting chronology were probably influenced by spring weather conditions, which may have also affected clutch size indirectly. Night Heron productivity in Alberta in 1964 and 1965 was insufficient to maintain the population. The major factor responsible for low productivity was destruction of eggs and predation on nestlings by Ring-billed Gulls (*Larus delawarensis*).

Mortality of nestlings was heaviest during the first week after hatching. Fledging took place at about six weeks of age. Nestlings could be aged up to three weeks of age on the basis of four measurements.

Fish, the staple food of most herons, were available in irrigation canals and ditches from the Bow River and Lake Newell Reservoir. It was thought that the impoundments provided feeding areas, especially where the irrigation ditches flow into them. Night Herons took advantage of their nesting association with Franklin's Gulls (*Larus pipixcan*) and blackbirds by preying on the young of these species. Availability of fish and young marsh birds roughly corresponded with the period when young Night Herons were in the nests. There was no indication that food was a limiting factor.

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Adult and nestling Black-crowned Night Herons at Beaverhill Lake near Tofield, Alberta (courtesy of C. G. Hampson).

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INTRODUCTION

Distribution

The genus *Nycticorax* has a cosmopolitan distribution in tropical and temperate regions of the world. The Black-crowned Night Heron, *Nycticorax nycticorax* (Linnaeus), breeds widely in North and South America, across Eurasia, and in Africa. In Australia it is replaced by another member of the same genus, *N. caledonicus*. Two other species of the genus *Nycticorax* occur in South America. Black-crowned Night Herons in North America belong to the subspecies *N. n. hoactli* (Gmelin).

In Canada this Night Heron has been reported from Manitoba and Saskatchewan for several decades (Seton, 1891; Gross, 1923; Godfrey, 1950). Likewise the species has occurred in the Dakotas and rarely in northeastern Montana for many years (Saunders, 1921).

The first official record for Alberta, however, was in May, 1958 (G. Freeman, pers. comm.; Salt and Wilk, 1958; Salt, 1961). This record came from Strathmore, near Calgary (Fig. 1). The spread of the Night Heron was apparently very rapid after 1958, for the species was sighted at Beaverhill Lake near Tofield in the summer of 1959 (C. Hampson, pers. comm.). Other sightings of Night Herons in Alberta have been scarce and unpublished. Two juvenile birds were collected in 1959 near Coal Lake by D. A. Boag and were deposited in the University of Alberta Museum of Zoology (nos. 1131 and 1132). A. J. Erskine (pers. comm.) observed many Night Herons at

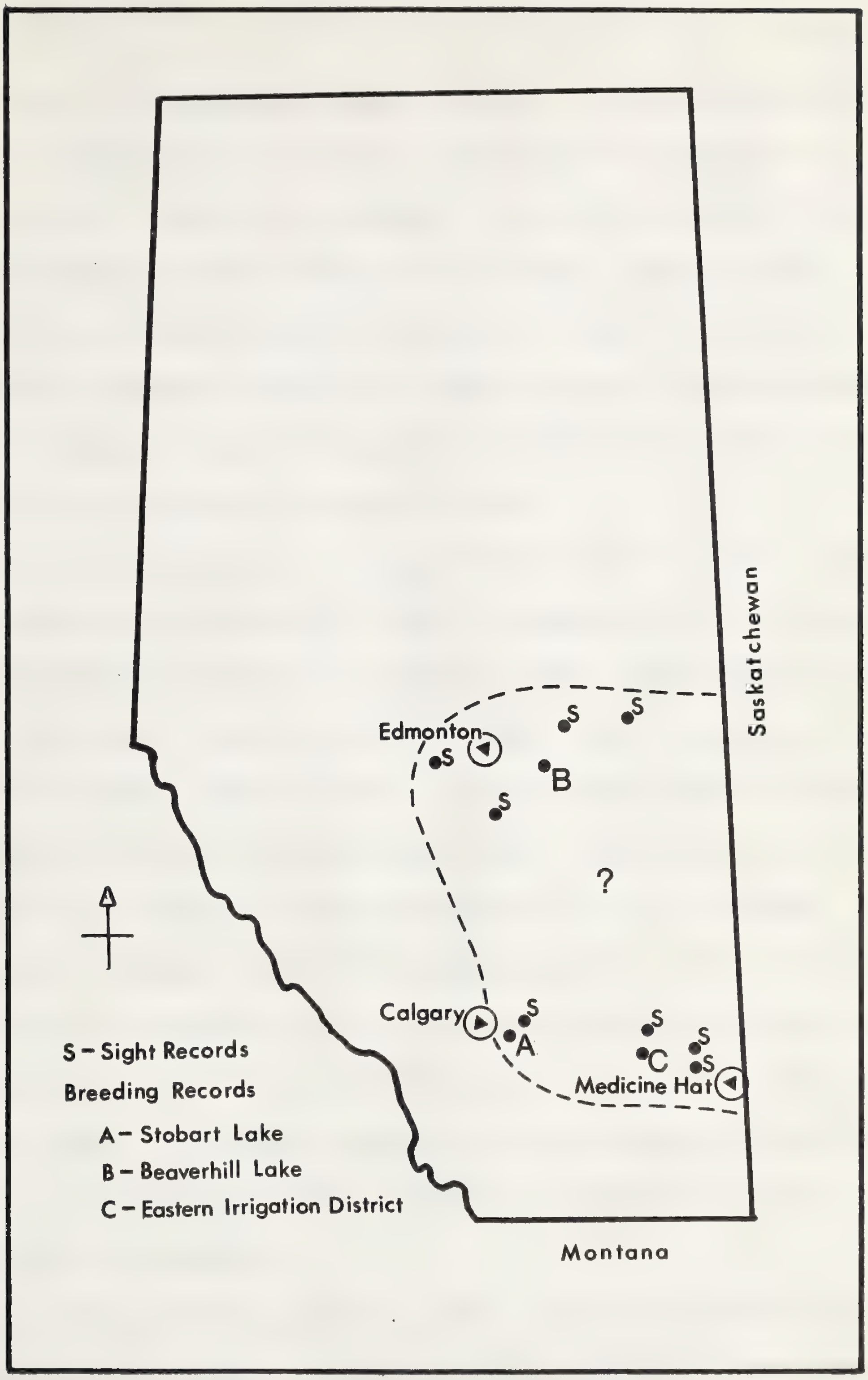

Figure 1. Sightings and breeding records for Black-crowned Night Herons in Alberta.

Lower Therion Lake near St. Paul in August, 1964; however, in May of 1965 no herons were seen there. Erskine suggested that the birds he saw in 1964 represented a premigratory concentration. Further sightings in central Alberta were from Whitford Lake and Lake Wabamun (R. Lister, pers. comm.). I observed that Night Herons were fairly common and widely distributed between Brooks and Medicine Hat; these birds were seen from the air while flying on an antelope survey with provincial biologists in August, 1964.

Breeding records for the province also are few. Night Herons nested at Beaverhill Lake in numbers up to 26 pairs from 1959 through 1964 (C. Hampson, pers. comm.; Salt, 1961). A few nests were found at Stobart Lake near Strathmore in 1964 (G. Freeman, pers. comm.). S. G. Sealy (pers. comm.) discovered a large nesting colony near Cassils in 1963. He estimated the number of nests at 300. As will be seen, this population of Night Herons decreased greatly after 1963. I found nesting aggregations in 1964 and 1965 near Tilley and Rainier; these and the colony near Cassils were investigated in this study. Figure 1 presents the locations of all known sightings and nesting records and the estimated range of the Night Heron in Alberta.

All nests found in Alberta were located in emergent vegetation over water. Generally, only extensive marshes in proximity to large bodies of open water were utilized by the nesting Night Herons.

Literature and Objectives

Most of the previous studies of Night Herons have been

on their behavior. Allen and Mangels (1940) provided an excellent analysis of courtship behavior, while Noble, Wurm, and Schmidt (1938) and Noble and Wurm (1942) studied the behavior of Night Herons in aviaries. Gross (1923) studied a huge colony at Sandy Neck in Massachusetts, and most of his efforts were devoted to censuses and studies of plumages, growth of young, and food habits. Bent (1926) summarized the available information and pointed out that the Night Heron nests in trees throughout eastern North America and on the West Coast, whereas it nests mainly in marshes in the Great Plains states and prairie provinces. No quantitative studies of the reproductive biology have been made nor have Night Herons nesting in marshes been studied.

My objectives were to investigate the productivity of Night Herons nesting in southern Alberta marshes, and to determine the major limiting factors controlling their success and spread in the province.

STUDY AREAS

The geographic relationships of the Cassils, Tilley, and Rainier study areas are shown in Figure 2. This portion of southern Alberta is a region of generally flat mixed prairie at an elevation of about 2500 feet. Under normal conditions it is semi-arid, resulting from low precipitation in the rain shadow of the Rocky Mountains and dry prevailing winds. Keith (1961) gives 20-year averages of 9 inches of rain and 39 inches of snow per year. The dominant genera of grasses are *Stipa*,

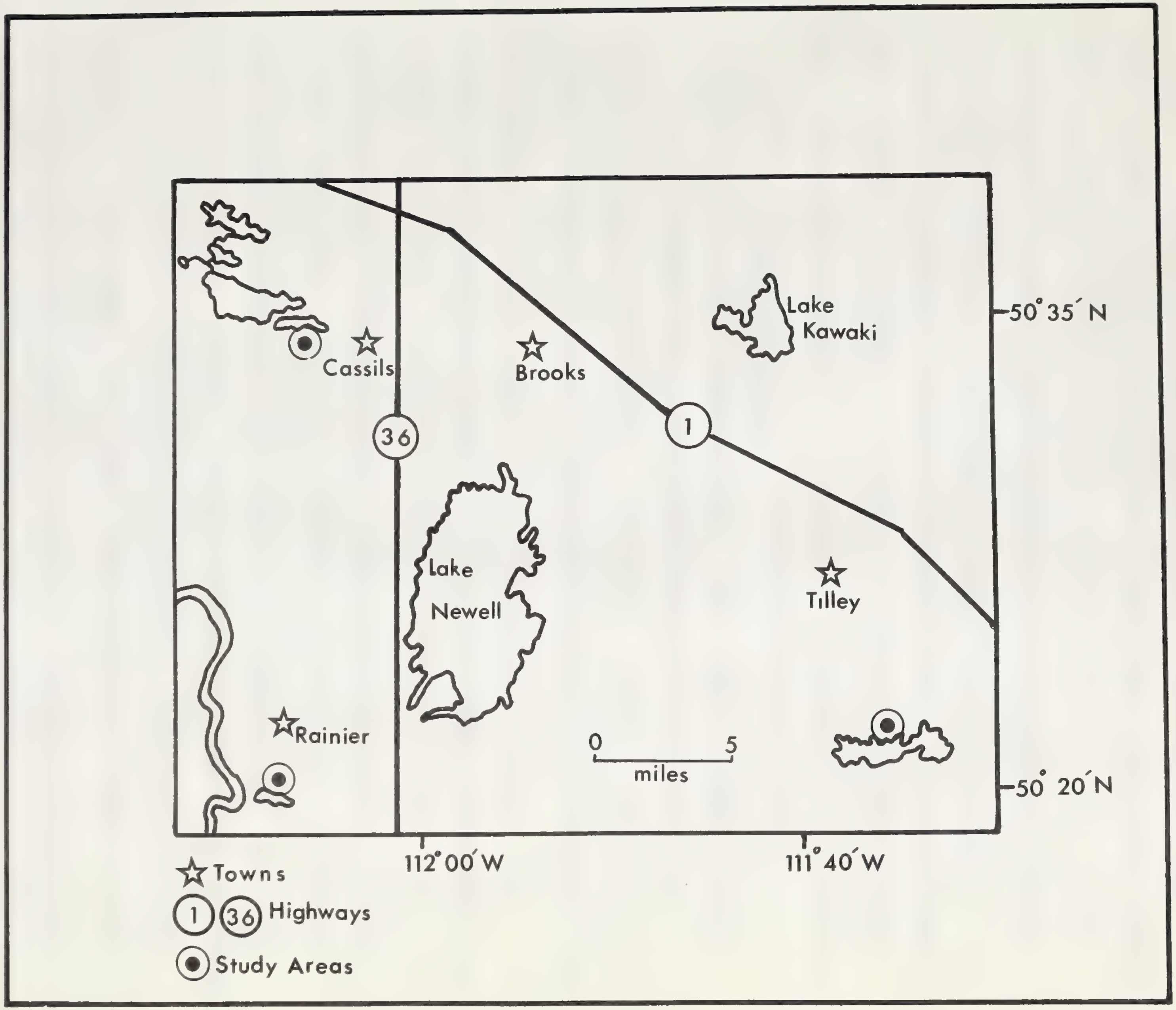

Figure 2. Portion of Eastern Irrigation District showing locations of study areas near Cassils, Tilley, and Rainier, Alberta.

Bouteloua, Agropyron, and Koeleria (Coupland, 1950). Over this flat land are numerous depressions of varying sizes. The majority contain water during the spring and summer months but gradually dry up in late summer and fall. Most of the depressions are very shallow and characteristically possess emergent vegetation straddling the land-water interface. The transition from terrestrial to aquatic habitat is very sharp; the ecotone, if present, is narrow. These aquatic habitats are alkaline (pH about 9.5). Emergent vegetation is dominated by cattail (Typha latifolia), with much lesser amounts of roundstem bulrushes (Scirpus spp.) and sedges (Carex spp.).

All the marshes investigated were located within the Eastern Irrigation District of Alberta. Keith (1961) has given a detailed history and description of this region. The development of an irrigation system in this area was the result of cooperative efforts of the provincial government and Ducks Unlimited. Irrigation began in 1917, but not until 1938 did Ducks Unlimited begin building impoundments. These "duck factories" are lakes in which the water levels can be maintained throughout the spring and summer months by using surplus irrigation water. The major water source for irrigation is the Bow River, and the most important reservoir is Lake Newell. Lake Newell and other reservoirs are large and deep lakes with little emergent vegetation. Some of these reservoirs support sufficient populations of whitefish and pike to sustain commercial fishing. A maze of canals and ditches dissects this Irrigation District and connects many of the lakes and associated marshes. The canals from the river and reservoirs

are opened each year in mid-May and closed in early September.

Each of the marshes investigated was surrounded by natural prairie which was grazed by cattle. Figure 3 shows the position of the marsh near Cassils in relation to San Francisco and Oakland Lakes. These lakes were impounded by Ducks Unlimited in 1944. The contours of these lakes are regular and the depths shallow, with a maximum of 5 feet. They are all interconnected by irrigation ditches.

The marsh in which the herons nested was not connected to San Francisco Lake nor to the irrigation system; hence its water levels depended entirely upon relative amounts of runoff, precipitation, and evaporation. The water depth in this marsh varied between 1 and 2 feet during the nesting period. Hereafter the cattail marsh adjacent to San Francisco Lake will be termed "Cassils" marsh.

Figure 4 shows the areas of Cassils marsh which the nesting herons utilized. There were three distinct colonies. Colonies A and B represented sites of initial nesting, whereas Colony R contained all but one of the replacement nests, built by some of the herons when their clutches were destroyed during incubation. Figure 5 shows the location of Colony A within the Cassils marsh. Cattails dominated the vegetation of the entire marsh, but a roundstem bulrush (Scirpus validus) appeared sparsely in Colonies B and R.

In 1965 no Night Herons nested in the vicinity of the Cassils area. On May 10, C. A. Gordon, Fish and Game Officer at Brooks, and I located a new colony of 55 pairs nesting near the northern shore of Scots Reservoir, southeast of Tilley,

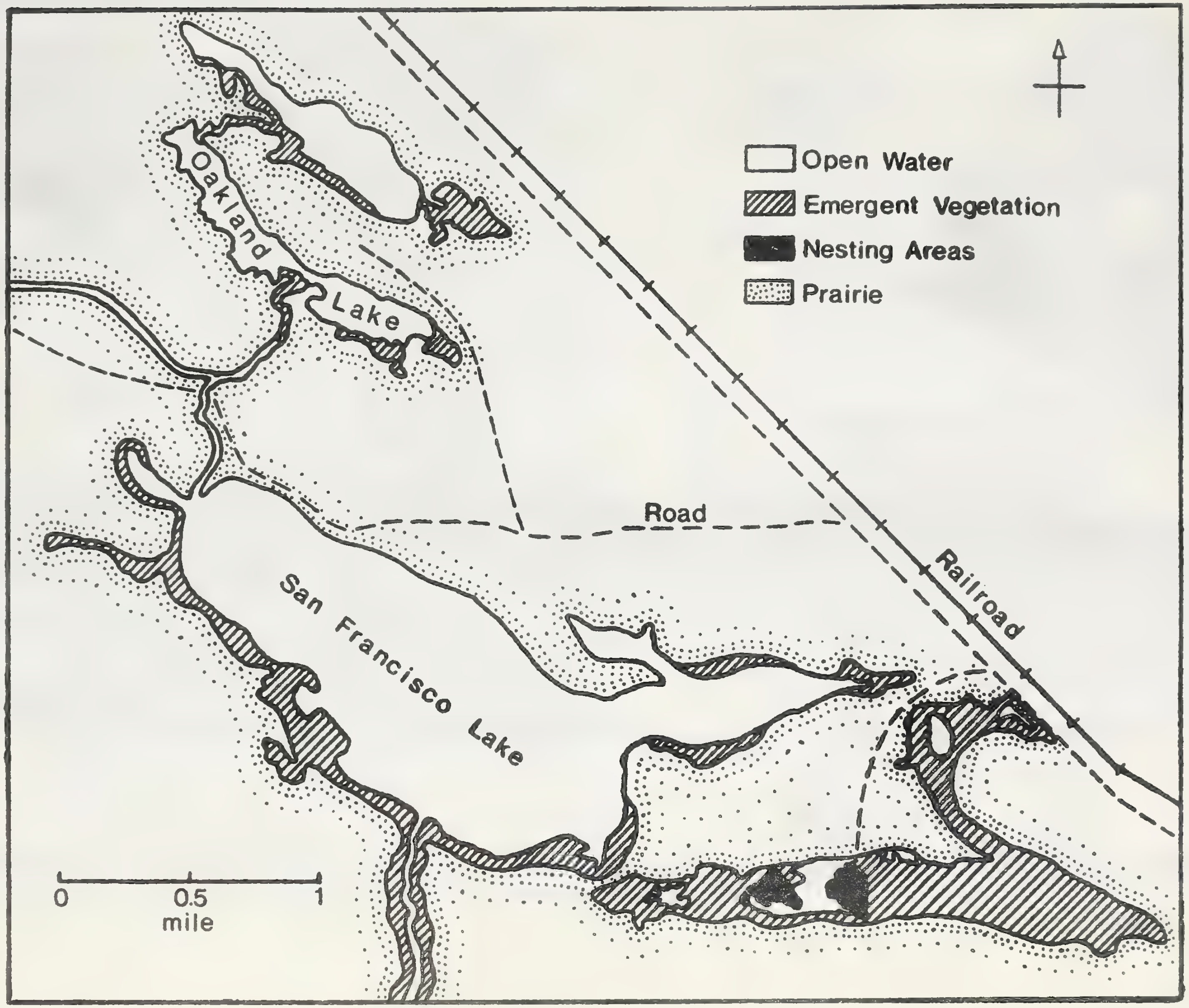

Figure. 3. Cassils study area, showing the marsh where Black-crowned Night Herons nested in 1964 and adjacent shallow lakes.

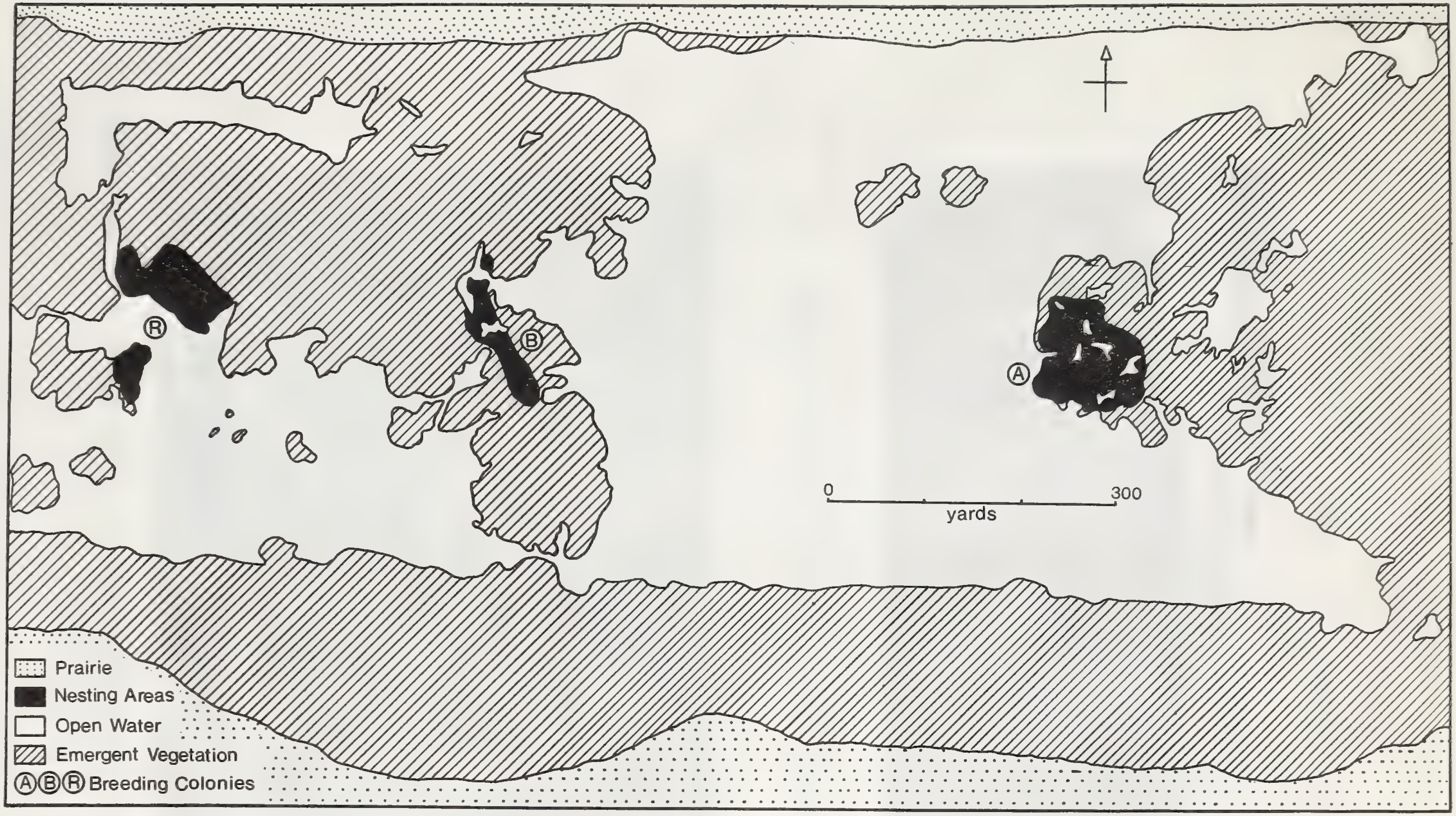

Figure 4. Portion of Cassils marsh showing locations of Black-crowned Night Heron Colonies A, B, and R, in 1964.

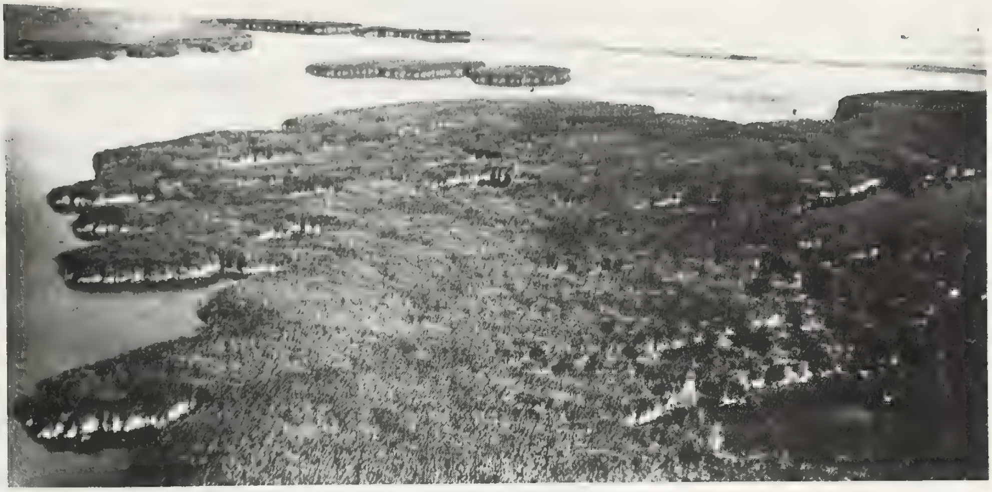

Figure 5. Portion of Cassils marsh showing cattail beds used by nesting Black-crowned Night Herons at Colony A, August 1, 1964.

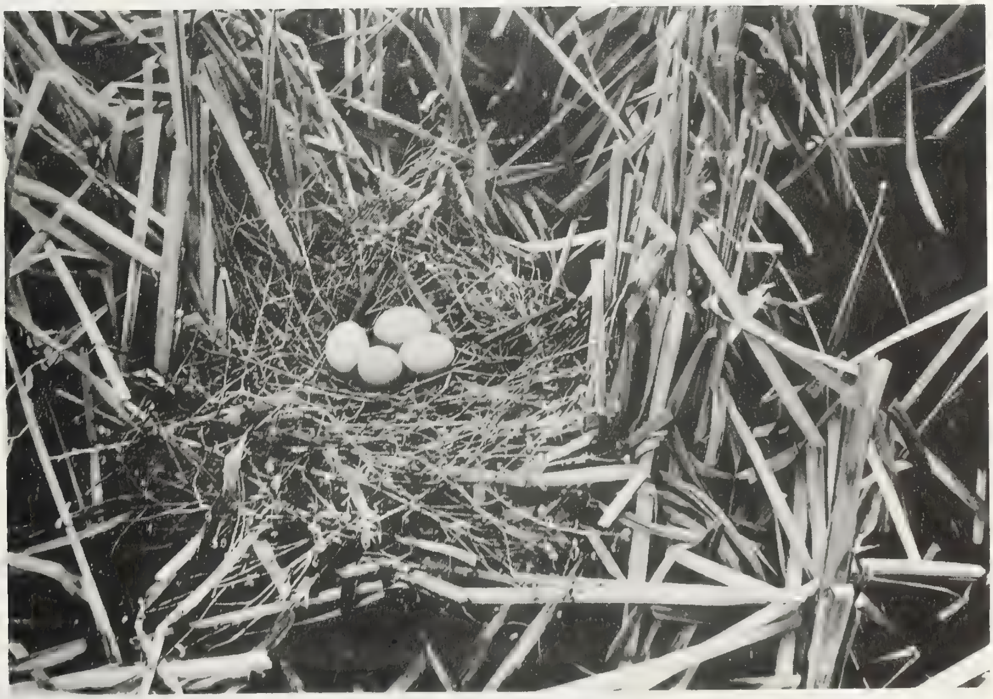

Figure 6. Typical Black-crowned Night Heron nest and clutch at Cassils, Alberta, May, 7, 1964.

Alberta. Here the nests were concentrated in two long narrow cattail "islands". The water below the nests was approximately 4 feet deep. Most of the vegetation was floating with only a small number of cattails actually rooted. Residents said that in past seasons these "islands" had been blown from one end of the lake to the other by strong winds. This did not happen in 1965. Some herons built replacement nests in an extensive cattail marsh a few hundred yards west of the nesting islands. Here again the water depth was about 4 feet, and most of the cattails were floating. Figure 7 shows where the herons nested in this Tilley study area.

In 1964 C. A. Gordon located a small colony of Night Herons nesting south of Rainier, Alberta. The marsh here was close to the Bow River, but no lakes were nearby. Water depth was about 3 feet. Cattails formed a rather narrow belt surrounding the marsh, and large open water areas were present. Near the center of this marsh the Night Herons nested in a few small clumps or "islands" of bulrushes. In 1965 the birds utilized the same bulrush clumps. Within 100 yards of the nests on the north bank of the marsh were a few cottonwood trees where the herons often perched, especially when flushed from their nests.

Nearly all of the quantitative data were obtained from the Cassils and Tilley study areas, since the population at Rainier was small.

Several other species of birds nested within or near the night heron aggregations. Franklin's Gulls (Larus pipixcan) dominated the marsh-nesting birds at the Cassils and Tilley

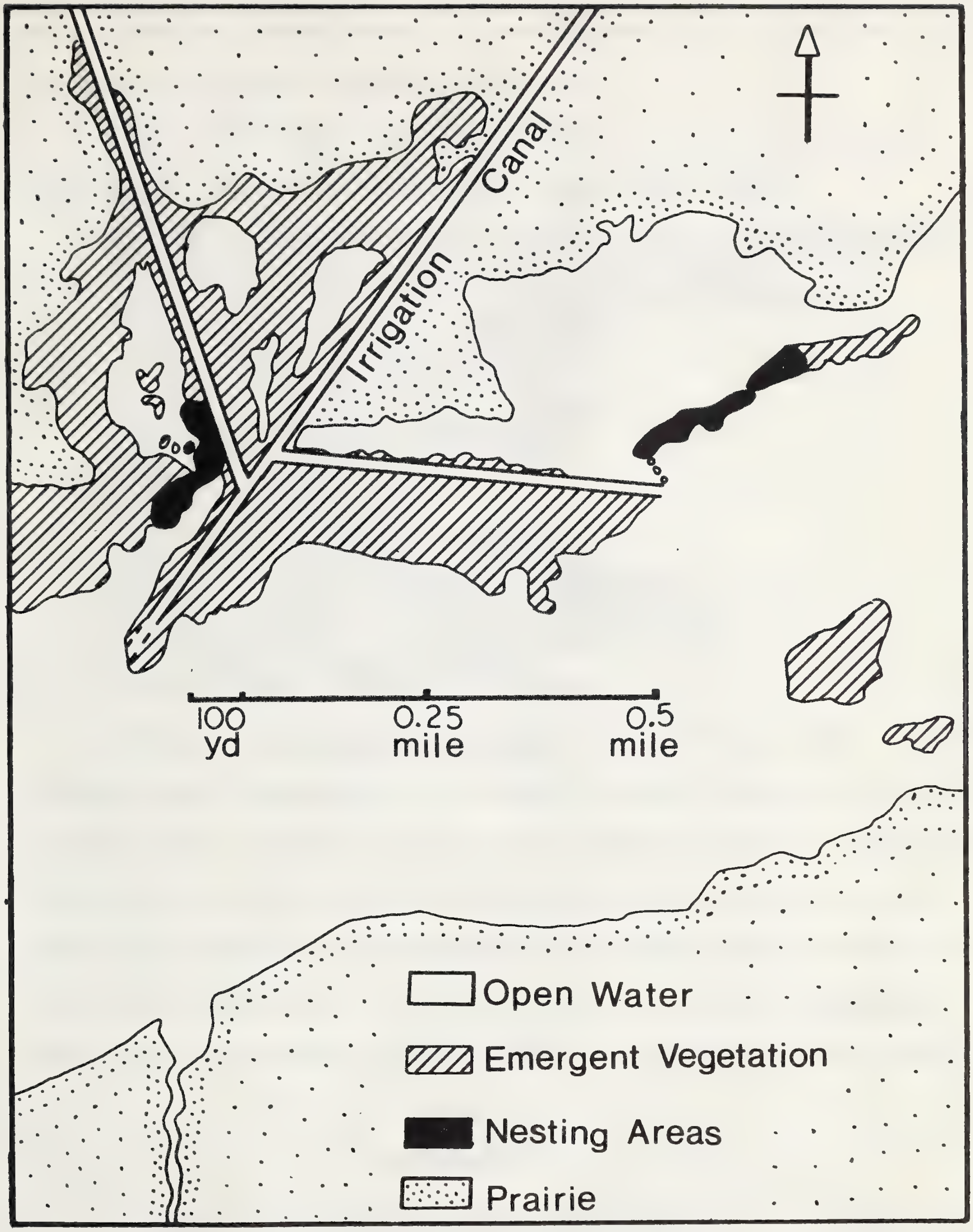

Figure 7. Portion of Scots Reservoir southeast of Tilley, Alberta, showing Black-crowned Night Heron nesting areas.

marshes. At least 4000 nests were concentrated east of Colony A at Cassils, while about 500 nests were found just north of the renesting Night Herons at Tilley.

The other avian species coinhabiting the marshes, in approximate order of decreasing abundance, were:

Yellow-headed Blackbird (Xanthocephalus xanthocephalus)
Redwinged Blackbird (Agelaius phoeniceus)
Long-billed Marsh Wren (Telmatodytes palustris)
American Coot (Fulica americana)
Canada Goose (Branta canadensis)
Mallard (Anas platyrhynchos)
Yellowthroat (Geothlypis trichas)
Ruddy Duck (Oxyura jamaicensis)
Black Tern (Chlidonias niger)
Redhead (Aythya americana)
Pintail (Anas acuta)
Sora Rail (Porzana carolina)
Eared Grebe (Podiceps caspicus)
Red-necked Grebe (Podiceps grisegena)
Pied-billed Grebe (Podilymbus podiceps)
American Bittern (Botaurus lentiginosus)
Marsh Hawk (Circus cyaneus)
Virginia Rail (Rallus limicola)

Muskrats (Ondatra zibethicus) were fairly common in all study areas, especially at Tilley in the floating cattails. Several other mammals utilized the marshes for drinking water, but they were never seen to enter the emergent vegetation. The only exceptions were in August of 1964 when the Cassils marsh was nearly dry. At that time both skunks (Mephitis mephitis) and coyotes (Canis latrans) hunted in the cattails.

METHODS

In 1964 field work commenced May 6 and ended August 18. Additional observations were made on April 4 and 24, August 25, and September 1, 7, and 14.

In 1965 field work began April 24 and ended September 1.

The Night Heron colony at Tilley was not located until May 10.

Habitat Analysis

Estimates of species composition and coverage values for emergent vegetation were obtained in each marsh where herons nested. This was done by means of linear transects with a 100-foot tape. The numbers and directions of transects used were determined by the relative sizes and shapes of the nesting areas. That is, transects on long islands followed the directions of those islands, and fewer transects were run in the smaller areas.

A total of 14 transects or 1400 feet was run at Cassils, six transects in Colony A and four each in Colonies B and R. At Tilley I used eight transects in the area where herons initially nested and four transects across the colony of replacement nests, for a total of 1200 feet. The Rainier nesting islands were of such small size that only six 50-foot transects totaling 300 feet were used.

All of the transects were run during May, before the new growth was well under way. Thus the results obtained were measures of the past year's remaining emergent vegetation. An arbitrary scheme of canopy coverage was adopted. This was based on the distributional pattern of the emergent plants. Inspection of these marshes revealed that the vegetation usually was quite dense although the clumps or individual plants were characteristically spaced. Thus there was either complete or no coverage along a transect line. Therefore, only slight

openings in the vegetation or small ponds within the marsh were measured. The per cent coverage for a transect represented the number of feet over which the coverage was total.

Reproductive Biology

The colonies at Cassils were visited once or twice daily. Most visits were made early or late in the day after I found that some nestlings were killed by the heat of the midday sun while nests were unattended. In 1965 the visits to Tilley and Rainier were alternated. Thus each of these areas was checked three or four times weekly.

Each nest within the Cassils marsh, when located, was marked with a 2.5-foot wooden stake. Because of deeper water at Tilley and Rainier, numbered paper tags were tied to each nest in these colonies. The construction of each nest was recorded. Most nests were measured. The four measurements taken were long and short diameters, depth of cup, and height of the nest rim above water. Distance from each nest to its nearest neighbor was measured.

Whenever possible the laying sequence of the eggs was recorded by numbering them with a felt marking pen. Lengths and widths of 337 eggs were measured with calipers.

The incubation period was considered to be the number of days between the laying and hatching dates of the final egg in a clutch (Moreau and Moreau, 1940). Dates of egg-laying in many cases had to be post-dated from the hatching dates. This was done by subtracting the average incubation period from the date of hatching.

After hatching, the down of the nestlings was marked with nail polish. In this way each nestling could be distinguished from its siblings until permanent aluminum bands were applied between the ages of six and ten days. Nesting areas were searched thoroughly after the hatching period to determine how many young birds survived to fledging.

To obtain growth curves, four measurements were taken periodically on every nestling. A spring balance, accurate to 10 grams, was used to weigh the birds. Calipers or a steel tape were used to measure, to the nearest half-millimeter, the culmen, wing arc, and tarsometatarsus (tarsus). A total of 350 sets of measurements was taken.

Food Habits

A total of 25 Night Herons was collected. The stomach contents of these birds were examined. The relative numbers of each type of food in each stomach were recorded. Regurgitations from nestlings were collected and analyzed in the same way. A nestling could often be coaxed to regurgitate by massaging its stomach and esophagus. A total of 96 such samples was analyzed.

The feeding areas known to be used by the Night Herons were sampled for potential prey. In 1965 this was done primarily in the Cassils area. A total of 20 samples was taken with a long-handled dip net swept through the water several times.

Plumages

Night Herons in the field can be aged up to three years, based on the plumage descriptions of Gross (1923) and Bent (1926).

Birds in brown plumage are either "juveniles" (birds of the year) or "immatures" (one year old). Immatures are considerably lighter in color and less streaked than the juveniles. Two-year-olds are "subadults" ("dusky adults" of Allen and Mangels (1940)). Night Herons which are three years old or older are "adults". Subadults appear to be much grayer than the white adults, and the dark patches on the crown and back are smaller in the subadults.

RESULTS

Heron Colonies

S. G. Sealy found approximately 300 pairs nesting at Cassils in 1963. In 1964 the Night Herons nested in exactly the same portion of the marsh, but the number of pairs had dropped to 71. Sixty-two of these pairs nested in Colony A, the remaining nine nesting in Colony B (Fig. 4). Fifteen of the initial pairs laid replacement clutches. No Night Herons nested in this area in 1965, although birds were observed to be feeding on the adjacent lakes throughout the season.

At Tilley 55 pairs nested in 1965. Twenty-two of these pairs laid replacement clutches. The number of pairs nesting at Rainier was 11 in 1964 and 6 in 1965.

The vast majority of the nesting night herons were adults. The subadults accounted for 5 to 10% of the Night Heron population. Allen and Mangels (1940) observed this age-class to contain breeding birds. My observations indicated that most if not all of the subadults were nesting.

The number of immature Night Herons present was difficult to determine. They arrived later than the adults and none of them nested. However, two small eggs in nests of adults may have been laid by immatures (page 24). Immatures were seen carrying nesting materials, and a few crude platforms in the marshes may have been built by these birds. Noble *et al.* (1938) and Noble and Wurm (1942) stated that immature birds did breed in aviaries. However, no one has demonstrated that these yearlings ever nest in nature. In the nesting colonies I observed immatures in about the same proportion (5 to 10%) as subadults; this is speculative and undoubtedly conservative, since immatures range widely and many do not appear in the nesting areas.

Vegetation Analysis

The Night Herons nested in the previous year's growth. This vegetation was relatively short, extending 2 to 3 feet above the water level. It provided little shelter but did provide nest sites and construction materials. The importance of cover afforded by marsh vegetation to nesting herons was difficult to evaluate. Table I shows the percentage of the water surface taken up by emergent plants in the areas used by nesting Night Herons.

Cattail dominated the Cassils marsh and was the exclusive emergent at Tilley. Bulrush was utilized at Rainier and occurred sparsely at Cassils. In all nesting areas total emergent coverage was high.

Table I. Percentage of water surface covered by vegetation in Night Heron nesting areas.

	Per Cent Coverage		
Location	Typha	Scirpus	Total Plant Coverage
Cassils - Colony A	87	0	87
Colony B	90	5	95
Colony R	84	9	93
Tilley	80	0	80
Rainier	0	85	85

Arrival and Colonization of the Marsh

In 1964 about 50 Night Herons were present at Cassils on April 24. No subsequent observations were made until May 6, when all breeding birds seemed to be present. In 1965 I observed only five birds until April 27 when 15 herons appeared at Cassils marsh. These 15 flushed from Colony A used the previous year.

Immature Night Herons consistently arrived later than did the older birds. Immatures were first seen on May 13, 1964, and May 19, 1965.

Nest Locations

Night Herons commenced nesting soon after arrival, in late April. Two tendencies were apparent in the herons' choice of nesting sites. They nested as far away from solid land as possible. Often this involved the selection of islands of emergent vegetation, wholly or partially surrounded by open water, or extensive marshes where they could nest a good distance in from shore. Furthermore, there was a tendency to nest in proximity to open water. At Cassils 34 of 62 nests

in Colony A were within 10 feet of open water, which took the form of either small ponds within the vegetation or the large water areas at its periphery. All nests at Tilley and Rainier were placed close to open water because of the nature of these areas.

All but one of the replacement nests were located away from the groups of initial nests. Perhaps it was my disturbance in the marshes which caused these pairs to leave after their initial clutches were destroyed.

Measurements of distances between nests in 1964 are shown in Table II. It can be seen that the nests in Colonies B and R were more spread out than those of Colony A. The shortest distance between any two nests was 5.5 feet. This may give some idea of territory size of these Night Herons. The average distances presented do not indicate actual densities but only relative densities of the nests.

Table II. Distances between adjacent Night Heron nests at Cassils, 1964.

Location		Distances in Feet	
		Average	Range
Colony A	- 42 nests	12.9	5.5-30
Colony B	- 9 nests	29.1	9.0-60
Colony R	- 14 nests	22.8	12.5-100
Weighted Average	- 65 nests	17.3	5.5-100

Nest Construction

The major plants utilized by the Night Herons in nest construction were cattail, roundstem bulrush, gumweed (*Grindelia perennis*), and Russian thistle (*Salsola pestifera*)

(nomenclature from Moss, 1959). The cattails and bulrushes were present in the marshes as was the Russian thistle, clumps of which had been blown in. Dead gumweed plants of the past year were obtained at the edges of the marshes on the prairie. Gumweed was the only prairie plant used to an appreciable extent.

Table III shows the percentages of nests at Cassils which were made of the four major plant species. Most commonly nest construction consisted of cattails as a foundation for the nest, with the cup or nest proper a mixture of cattails and gumweed (Fig. 6). Usually the cup was lined with flat cattail leaves.

Table III. Percentages of Night Heron nests which were made from specific plant materials at Cassils, 1964.

	Per Cent of Nests		
Plants Utilized in Nests	Colony A 35 nests	Colony B 9 nests	Colony R 14 nests
Typha	97	67	100
Scirpus	6	89	21
Grindelia	97	56	36
Salsola	20	22	21

The above figures are interesting when compared with the composition of emergent cover (Table I). In Colonies B and R, where bulrushes were available, this plant was utilized to a considerable extent. In these nests the use of gumweed showed a corresponding decrease. The nests at Tilley in 1965 were formed of cattails, gumweed, and

Russian thistle in about the same proportions as in Colony A at Cassils. Bulrushes were not available at Tilley. At Rainier all nests were built with bulrushes, some of them lined with willow twigs (*Salix* spp.), grasses (*Stipa* spp.), or cattails.

Through the method of marking nests at Tilley, I found that the Night Herons often stole bits of material from neighboring nests. Several nests were found, during the incubation period, with two or more tagged pieces of vegetation in them. Furthermore, herons were seen carrying nesting material as late as mid-July.

Table IV presents the average measurements of 78 nests at Cassils. The nests were, on the whole, poorly built structures (Fig. 6). Roughly one-fourth were very flat and had no cup. Many nests were only slightly above the water level. This latter characteristic left them subject to flooding when water levels rose during rainy periods. A few nests were so flooded in 1965.

Table IV. Average measurements of Night Heron nests at Cassils, 1964.

Nest Group	Mean Values in Centimeters Long Diameter	Short Diameter	Height Above Water*	Depth of Cup
Colony A - 54 nests	47	42	16	4
Colony B - 9 nests	47	43	17	7
Colony R - 15 nests	51	46	27	6
Weighted Average for 78 nests	48	43	18	5

* Measured from nest rim

The heron nests of Colony R were higher above the water level simply because the new growth of marsh vegetation had become quite thick by the time the birds were building replacement nests. They utilized this new growth as a base for their nests. Replacement nests, in several instances, appeared to be built hastily and haphazardly. Others, however, were well constructed, comparable to the best in the initial series.

After the Night Heron nests were deserted in July and August, they were used widely by muskrats for feeding platforms and by various ducks for resting sites.

Reproductive Biology

Egg-laying

The chronological distribution of egg-laying and hatching is presented in Figure 8. The first eggs were deposited during the last week of April. Thirty-five per cent of the initial clutches in 1964 were completed before May 6, and 60% before May 10 in 1965. No clutches which were initiated early in the season and did not hatch, are presented in Figure 8 because the laying dates were unknown. Therefore, a complete distribution of laying would show somewhat earlier peaks than those shown in Figure 8.

In both years a few initial clutches were still being completed when replacement clutches were begun. The 1964 peak in laying for these renesting herons was about May 19, two weeks after the corresponding peak in initial laying. The scanty data from 1965 do not allow such peaks to be

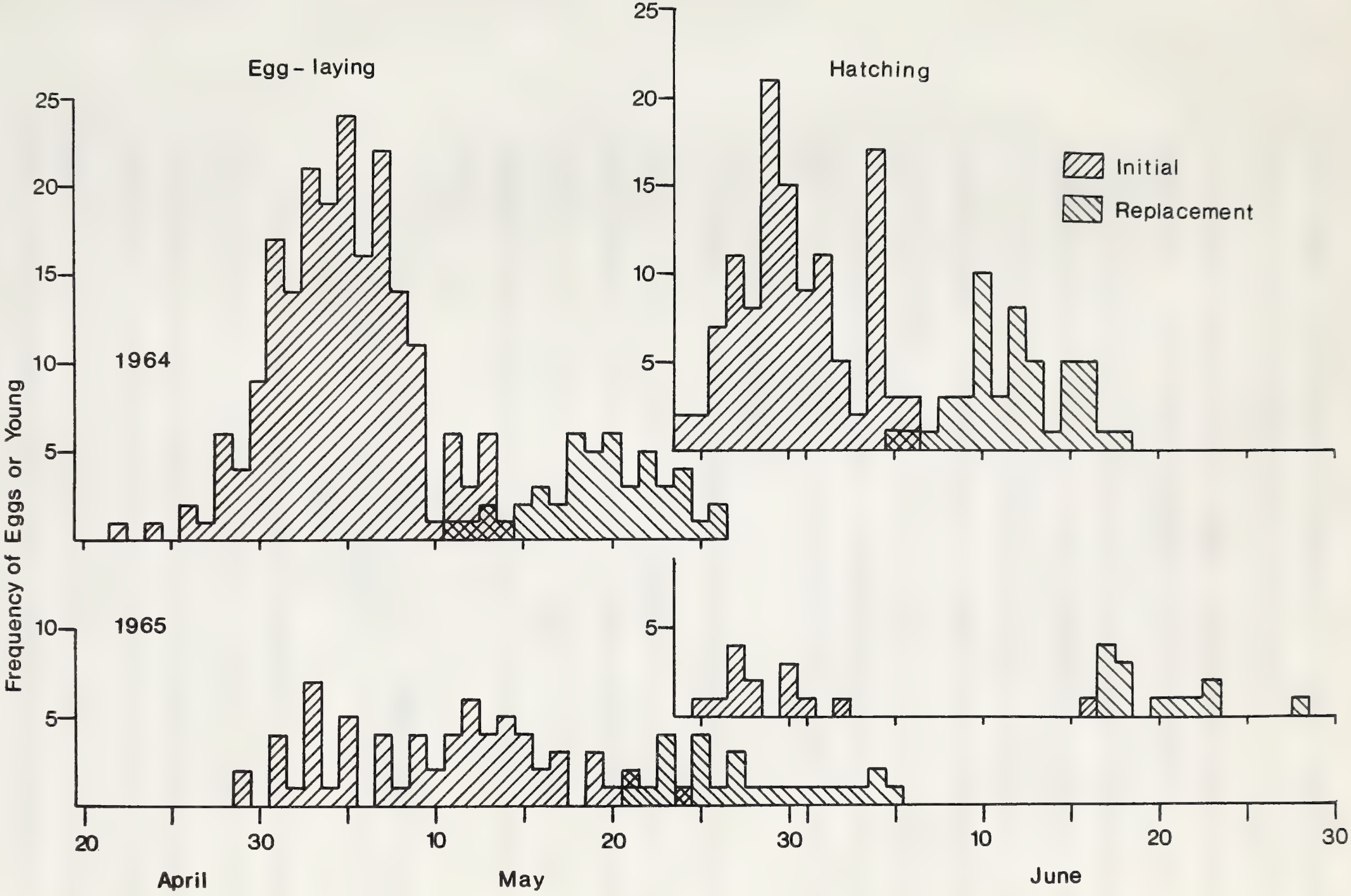

Figure 8. Egg-laying and hatching frequencies for Alberta Black-crowned Night Herons in 1964 and 1965.

determined. The overall lengths of the laying periods in the two years corresponded very closely, averaging 24.5 days for initial nests and 16 days for replacement. The laying periods in 1965 lagged behind those in 1964 by about a week.

The laying interval, or time elapsed between consecutive eggs in a clutch, was in most instances two days. About five per cent of the eggs appeared to come three days after previous eggs. Noble _et al_. (1938) found laying intervals to vary from 40 to 50 hours in captive Night Herons.

One instance of egg dumping was noted when a single heron egg was found in an abandoned Canada Goose nest.

Egg Measurements

Bent's (1962) average measurements of 48 eggs were 51.5 X 37 mm. I found the averages of 337 eggs to be somewhat larger, 52.4 X 37.7 mm. The extreme measurements noted were 62 X 41 and 47 X 35 mm. Bent's averages could not be compared statistically with mine. However, Welty (1962) writes:

> "The eggs of the White Heron, _Casmerodius albus_, are regularly larger in Europe than in India. Whether this is caused by an environmental or hereditary influence has yet to be determined."

Two very small eggs, not included in the above series, measured 46 X 33 and 29 X 25 mm. Both of these were infertile, the latter being yolkless, and were deposited during the incubation period, out of the laying sequence. These small eggs were possibly products of immature Night Herons, which were first sighted only a few days before the small eggs appeared.

Clutch Size

The frequencies of different clutch sizes and the average sizes are given in Table V. The 1964 clutch size data were accurate. In 1965 some egg depredation had already occurred when the nests were first found; hence the data on clutch size show minimal numbers. Only those clutches which showed no evidences of egg loss were recorded. The average clutch size in 1965 was therefore probably slightly higher than 3.20 recorded in Table V.

Table V. Frequencies and averages of Night Heron clutches in Alberta.

Location	Number of Eggs 1	2	3	4	5	6	7	8	Total	Clutch Size Mean ± S.D.
1964										
Initial	3	3	9	34	15	3	(3)*	(1)*	71	3.96 ± 1.06
Replacement	1	0	4	7	3	0	0	0	15	3.73 ± 0.99
1965										
Initial	0	4	31	14	0	0	0	0	49	3.20 ± 0.57
Replacement	3	6	8	2	0	0	0	0	19	2.48 ± 0.88

* not included in computation of mean clutch size

The large clutches of seven and eight eggs (all in Colony B) were thought to be products of more than one female at each nest and were not included in the computation of the mean. The laying intervals among the three or four final eggs in these clutches were too short for one female to have laid them all. I do not know the number of female herons involved at each nest, and thus the number of eggs contributed by each bird is unknown. All observed clutches of six were laid with normal egg intervals. I am confident that the largest clutch

from a single female Night Heron was six eggs.

The decline in average clutch size from initial to replacement clutches was 6% in 1964 and 22% in 1965. The decline in each year was significant at the five per cent level. The decline from 1964 to 1965 in average initial clutch size was highly significant ($P<.01$).

Incubation

Night Herons commence incubation after the second or third egg of the clutch has been laid. This produces staggered hatching in each nest. The generally low hatching success allowed only 11 incubation periods to be determined. Table VI shows that this period was variable (21 to 28 days), with a mean of 23.6 days.

Table VI. Distribution of observed incubation periods for Night Herons in Alberta.

Incubation in Days	21	22	23	24	25	26	27	28
Frequency Observed	1	1	4	3	1	0	0	1

Gross (1923) observed incubation periods of 24 to 26 days, but he neglected to mention whether these were for final eggs. Noble and Wurm (1942) stated that the incubation period varied from 22 to 24 days in captivity.

The incubation period variability probably was partially caused by individual variations in attentiveness among the adults. Another factor was the variable hatching period (described below).

Hatching and Young

Gross (1923) described the hatching process as somewhat

prolonged in the Night Heron. I found that after pipping the egg, most birds required about two days before they emerged. Hatching time could be lengthened by weather or by time of day. Hatching efforts ceased during adverse weather and at night.

The dates and frequencies of hatching are shown in Figure 8. In 1964, hatching in the initial nests occurred over a period of 14 days. This was considerably shorter than the 23 days during which the eggs were laid. On the other hand the respective periods for replacement nests were nearly equal, 14 versus 16 days. Hatching success was better in the replacement nests than in the initial nests. Heavy losses of eggs in the initial series of nests, including early and late clutches, shortened the total hatching period for initial nests.

Soon after the young had hatched the nests became disordered and covered with limy feces. The nestling birds became quite active at only a few days of age. The term "nestling" is here defined to include all young which are incapable of flight. When approached the nestlings often fell out of the nests into the water in attempting to escape. They were subsequently replaced in their nests. After they were two weeks old they regularly climbed out of the nests and scattered at any disturbance. My regular visits and attempts to obtain measurements of the young herons tended to scatter them throughout the nesting areas. Thus some of the older nestlings were found far from their parents' nests, often near the nests of other individuals. This may have had some effect

on nestling mortality.

The duration of the nestling period was determined for three birds. These birds were found capable of weak flight at the ages of 39, 40, and 42 days respectively. Thus it was nearly six weeks after hatching before the young Night Herons could leave the nesting areas. When a young bird first achieves successful flight, it becomes a "fledgling" or juvenile.

Figure 9 shows the growth curves from nestling weights and measurements. Appendix I gives the averages and sample sizes from which these curves were constructed. All but a few nestlings could be accurately aged up to three weeks of age by using these growth characters. Sample sizes above three weeks of age were too small to indicate the growth trends accurately.

Productivity

Reproductive success of the Night Herons was fair in 1964 and poor in 1965. The productivity figures in 1964 and 1965 are shown in Table VII. The clutches presented in Table VII are ecological clutches, which are the numbers of eggs found in the nests. The large clutches of seven and eight eggs (see Table V) were used in computing the average of 4.14 because they represented potential increase to the species. Total production was 1.08 fledged young per breeding pair in 1964, compared with 0.11 young per pair in 1965. Since some pairs successfully raised a brood after losing their initial clutches, these figures include two nesting attempts for these pairs.

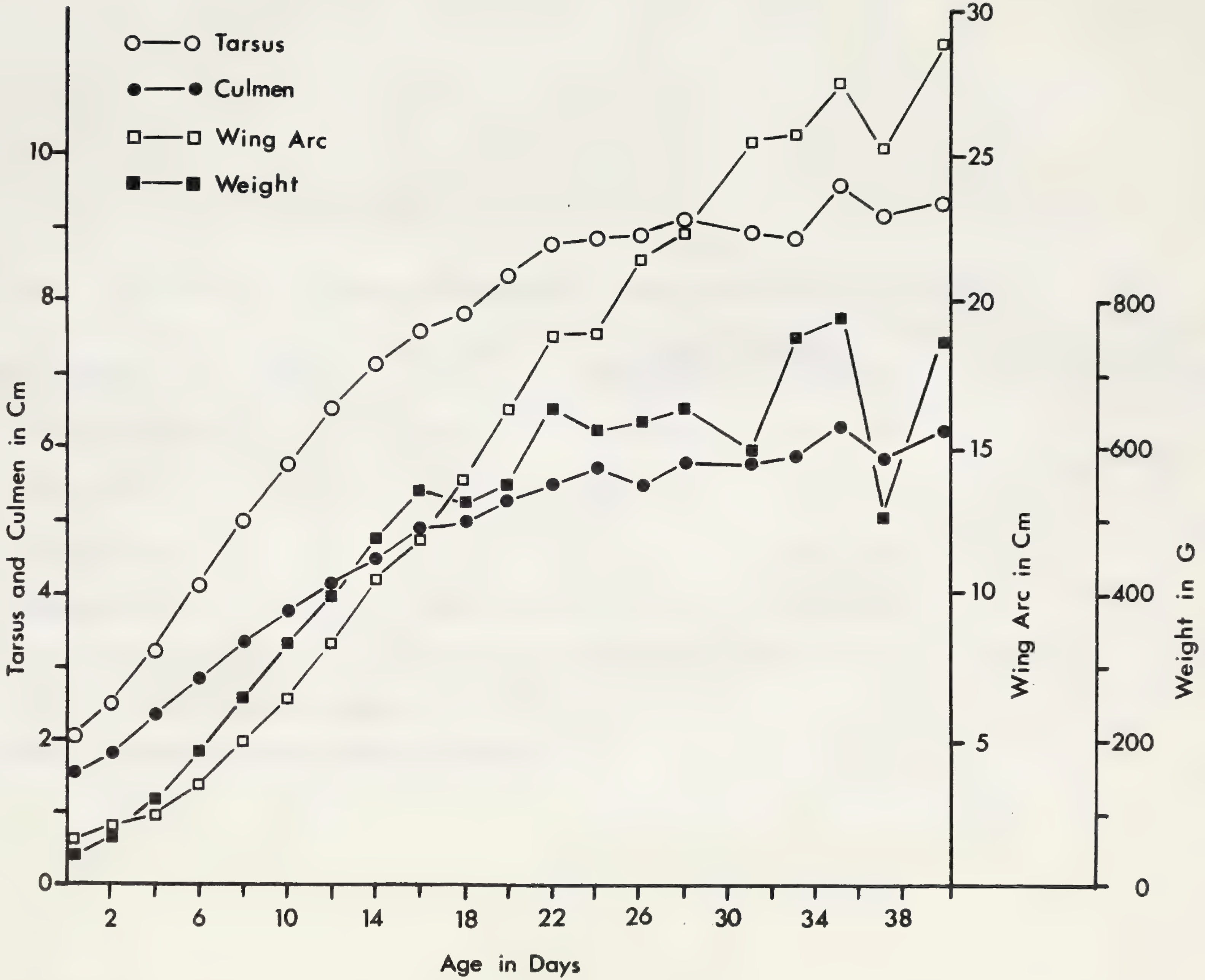

Figure 9. Growth curves for Black-crowned Night Heron nestlings at Cassils, Alberta, in 1964.

Table VII. Hatching and fledging successes of the Night Herons in Alberta.

Nest Group	Total Nests	Average Clutch	Number per Nest Hatched	Number per Nest Fledged	Total Fledged Per Breeding Pair
1964 - Initial nests	71	4.14	1.38 (33)*	0.72 (52)#	1.08
Replacement	15	3.73	2.80 (75)	1.73 (62)	
1965 - Initial nests	55	3.20	0.42 (13)	0.04 (10)	0.11
Replacement	22	2.48	0.56 (23)	0.16 (25)	

* Per cent of eggs which hatched

# Per cent of hatched young which fledged

There was a great difference in productivity in the two initial colonies at Cassils in 1964. The nine pairs in Colony B hatched 76% of their eggs, compared with only 25% hatching success in the 62 nests of Colony A. This was even more striking when clutch sizes were considered; clutches in Colony A averaged 3.96 eggs, and those in Colony B averaged 5.56 eggs.

Hatching success was low for initial nests in 1964 but much lower in 1965. Thirty-three per cent of the eggs in initial clutches hatched in 1964, and 13% hatched in 1965. In both years hatching success was better in replacement nests than in initial nests, significantly so in 1964.

The difference in hatching success between 1964 and 1965 reflected intensities of egg depredation. Table VIII shows fates of unhatched eggs. Those still in the nests were opened and examined directly for infertility.

Table VIII. Fates of unhatched Night Heron eggs in 1964 and 1965.

	1964		1965	
Unhatched Egg Fates	Initial 196 eggs	Replacement 14 eggs	Initial 145 eggs	Replacement 34 eggs
Depredated	115 (59)*	0 (0)*	126 (87)*	23 (67)*
Infertile	12 (6)	3 (21)	3 (2)	2 (6)
Addled	20 (10)	5 (36)	9 (6)	3 (9)
Fell in water	37 (19)	5 (36)	7 (5)	4 (12)
Abandoned	12 (6)	1 (7)	0 (0)	2 (6)

* Figures in parentheses represent per cent losses.

Fledging success, or the per cent of hatched young which lived to fledging age, also decreased in 1965. In 1964 55% of the young fledged, compared with 16% in 1965. There was no significant difference in fledging success of initial and replacement nests. Figure 10 shows survival curves for nestlings from hatching to fledging in the two years. Mortality was heaviest during the first four to five days after hatching. Causes of death were mainly drowning, heat prostration, heavy rains, and predation by Ring-billed Gulls (Larus delawarensis). At Cassils there was no loss of young to predators, but at Tilley, predation by gulls was the major cause of the nestling mortality.

Ring-billed Gulls were the only species responsible for taking eggs and young of the herons. They were seen taking eggs several times. Depredated eggs were either pecked and sucked (Fig. 11), broken (Fig. 12), or carried away by the gulls. These evidences were similar to those left by crows (Corvus brachyrhynchos) at duck nests (Rearden, 1951). At Tilley I also saw Ring-billed Gulls catch and eat heron nestlings. In 1965 the maximum number of gulls seen at one time near the nesting area was seven. Most of these showed immature markings, and they were assumed to be non-breeders. The depredation evidences in 1964 were the same as in 1965. I suspect that Ring-billed Gulls were the predators in 1964 also, although the maximum seen then was three.

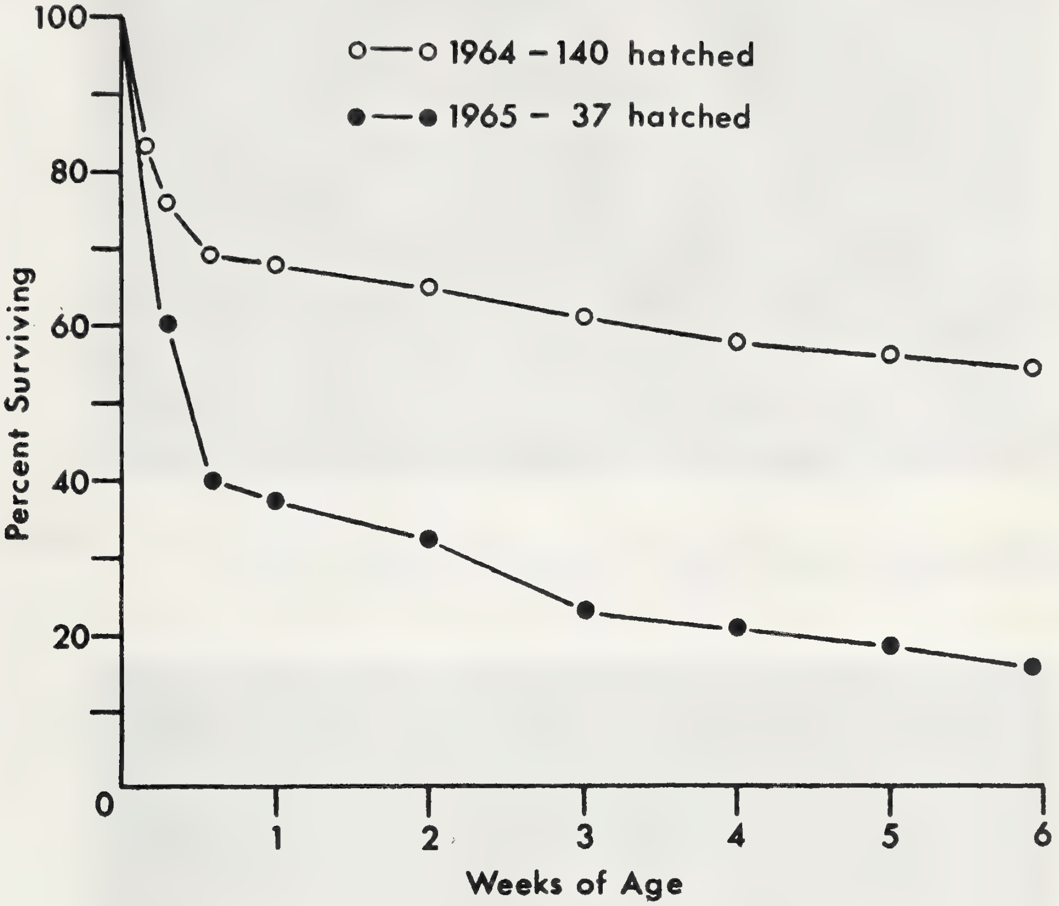

Figure 10. Survival of nestling Black-crowned Night Herons from hatching to fledging in 1964 and 1965.

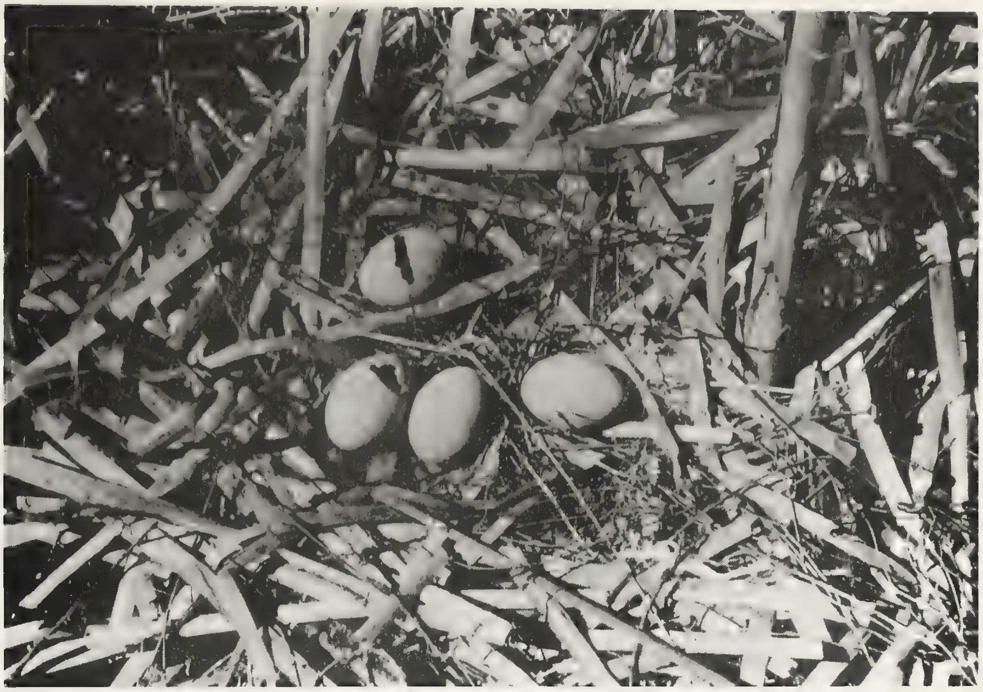

Figure 11. Egg depredation by Ring-billed Gulls, showing small holes pecked in the Black-crowned Night Heron eggs, May 12, 1965.

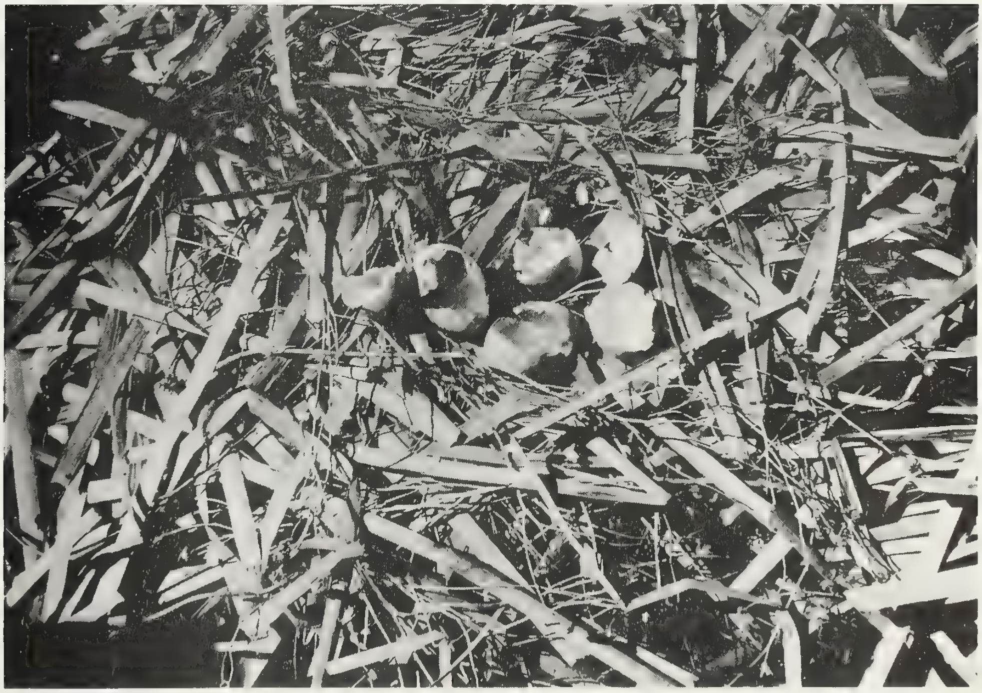

Figure 12. Egg depredation by Ring-billed Gulls, showing Black-crowned Night Heron eggs broken open and eaten, May 15, 1965.

Food Habits

Analysis of Prey Taken

The methods used in determining the food habits of the Night Heron were biased in favor of those prey which had indigestible parts. The herons possess powerful digestive juices which break down virtually all portions of their prey except fur, feathers, and perhaps chitin. Even vertebrate bones are slowly but completely broken down. Chitinous portions of arthropods are digested very slowly if at all. On the other hand, among the vertebrate prey, fish and amphibians are quickly digested by the herons; the importance of these groups was probably underestimated.

Table IX shows the results of analysis of regurgitated samples. All samples were collected from young Night Herons in June and July before the age of fledging. The analysis of stomach contents from collected birds is presented in Table X. These latter figures represent prey items late in the season from mid-July to late August. The figures given in the tables below are percentages of samples in which food items occurred in more than negligible amounts. Individual members of the prey groups are listed in order of decreasing importance.

The most common amphibian in the areas studied was the chorus frog (*Pseudacris triseriata*), and this species may be more important as a food item than indicated in the tables. All but a very few of the young birds eaten were Franklin's Gulls. Most of these were chicks less than a week old, and one chick appeared to be of pre-hatching size.

Table IX. Percentages of regurgitations from Night Heron nestlings in which food items occurred.

Prey Group	Per Cent Frequency 1964 (80 samples)	 1965 (16 samples)
Fish		
Fathead minnow (*Pimephales promelas*)	33	13
Brook stickleback (*Eucalia inconstans*)		
Lake chub (*Hybopsis plumbea*)		
Unidentified sucker (*Catostomus* sp.)		
Amphibians		
Leopard frog (*Rana pipiens*)	10	6
Tiger salamander (*Ambystoma tigrinum*)		
Dakota toad (*Bufo woodhousei*)		
Boreal chorus frog (*Pseudacris triseriata*)		
Birds (young)		
Franklin's Gull (*Larus pipixcan*)	58	75
Blackbirds (*Xanthocephalus* and *Agelaius*)		
Coot (*Fulica americana*)		
Night Heron (only 1 instance of cannibalism)		
Mammals		
Field vole (*Microtus pennsylvanicus*)	15	13
Coleoptera		
Carabidae and Dytiscidae	50	81
Hemiptera		
Corixidae and Notonectidae	13	13
Orthoptera	3	6
Odonata	5	0
Amphipoda	3	0
Hirudinea	5	6
Vegetation	10	19

Specific names of fish and amphibians follow the American Fisheries Society, 1960, and Logier and Toner, 1961.

Table X. Percentage of stomachs of older Night Herons containing prey items.

Prey Group	Per Cent Frequency 1964 (10 samples)	 1965 (7 samples)
Fish	30	29
Amphibians	0	0
Birds	10	0
Mammals	10	14
Coleoptera	60	57
Hemiptera	40	43
Orthoptera	20	0
Odonata	0	29
Amphipoda	10	29
Hirudinea	0	0
Vegetation	20	0

The predominant food of the nestlings was young birds. Next in importance were beetles and fish. Probably the fish were more important than beetles in terms of nutrition or biomass taken. Vegetation is eaten by the adults to aid pellet formation and by the nestlings when the parents are away feeding (Lowe, 1954). There were no samples composed mostly of plant matter.

The prey items within the groups listed in Table X are the same as those in Table IX, except the birds. The only birds taken were young Yellow-headed Blackbirds.

It was evident from the hard parts recovered that the coleopterans were the most important of the invertebrates taken by the Night Herons. The beetles eaten most frequently were rather small carabids, while adult and larval dytiscids were taken consistently but in much smaller numbers. The only

other important invertebrate prey were hemipterans, represented by corixids and notonectids.

Fish were probably the most important prey of the Night Herons. The biomass of fish taken certainly exceeded that of the invertebrates.

The dip-net samples of available aquatic food in 1965 contained mostly fish, snails, and amphipods, with lesser numbers of corixids and notonectids. As can be seen in Tables IX and X, no snails and few amphipods were taken by the Night Herons.

Feeding Areas

Figure 13 shows those places where adult Night Herons were observed feeding during the 1964 nesting season. These adults were assumed to be members of the Cassils nesting colony since no other nesting groups existed nearby. Some of the adults may have been nonbreeding birds.

The vast majority of the Night Herons hunted the irrigation ditches and lake shores up to 4 miles northwest of the nesting area. A few individuals and small groups dispersed to feed as far as 8 miles in all directions. The favored feeding areas were the irrigation ditches where they entered the lakes. Here there were areas of dense emergent vegetation and concentrations of small fish and aquatic insects. The wet grass along these ditches contained voles and carabid beetles in abundance.

At Tilley the herons did not gather in well-defined areas to feed. Most of them hunted along the shores of the reservoir, again usually near points where ditches or canals entered. The

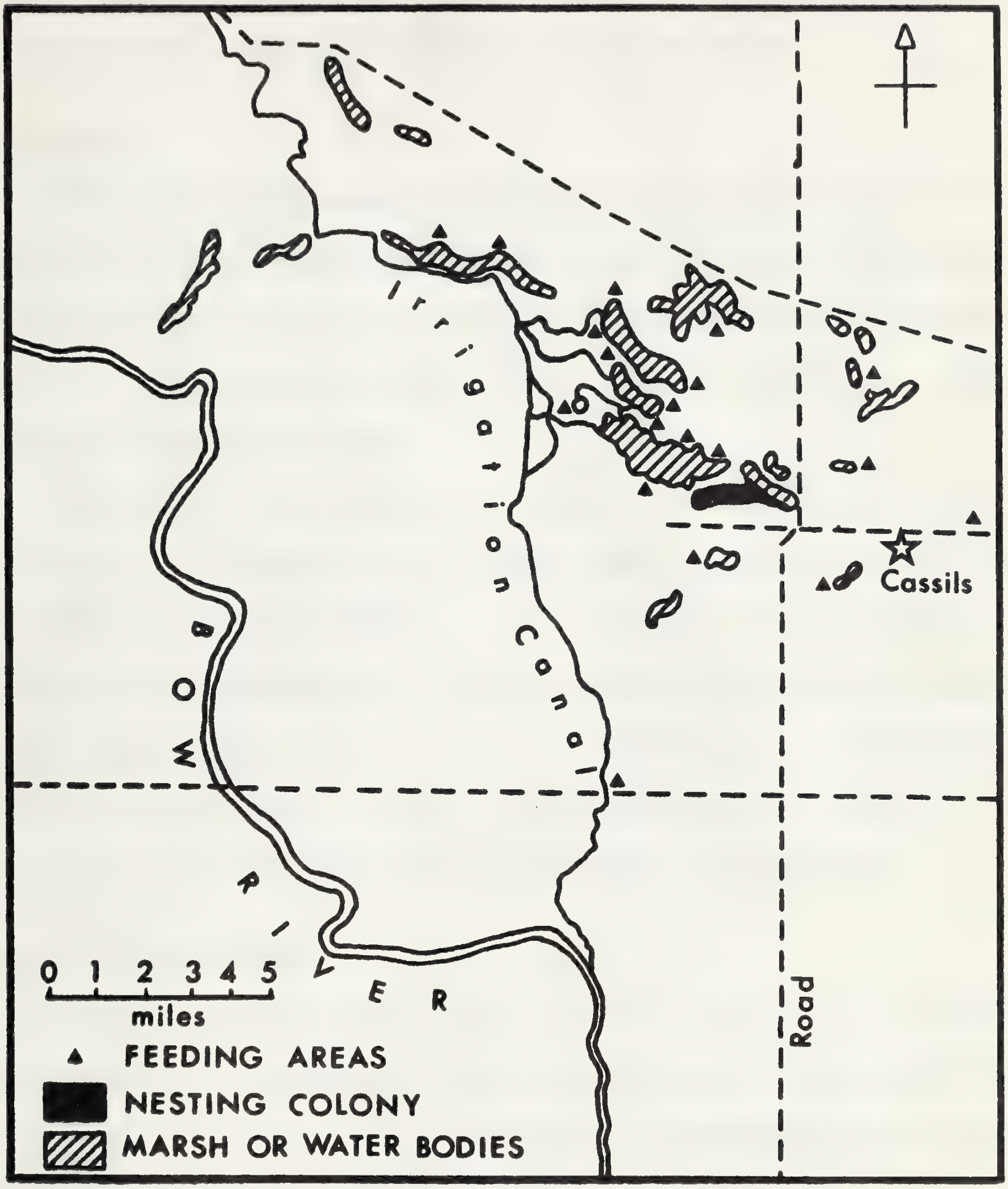

Figure 13. Feeding areas used by adult Black-crowned Night Herons from the Cassils nesting colony in 1964.

small population of Night Herons at Rainier did their feeding mainly in the marsh where they nested. A few of the birds occasionally hunted the banks of the Bow River.

Departure

The nesting marshes became gradually deserted as the young of the year fledged. This took place in the latter half of July, and by early August no Night Herons could be found in the nesting areas. They had all spread out, presumably to their feeding grounds.

Migratory departure in the fall took place during the first half of September in 1964. Most older birds left between September 1 and September 7, and only one juvenile heron remained on September 14. The University of Alberta Museum of Zoology contains two juvenile females shot on September 19, 1959, at Coal Lake, Alberta. This shows that some juveniles may remain in the province later than mid-September.

Banding Operations

Hickey (1952) states that western populations of Night Herons generally migrate to wintering grounds in Mexico and Guatemala. There is a great deal of individual variation in these migratory movements.

S. G. Sealy banded 140 nestling Night Herons at Cassils in 1963. I banded 105 in 1964 and 10 in 1965. One of the 1964 juveniles, No. 637-92571, was found dead near Gothenburg, Nebraska (40°50' N, 100°10' W), on October 10, 1964. Probably this juvenile was still on its way south when it died.

No birds banded by Sealy or myself were seen in the study

areas in subsequent years after banding. I am confident that all Night Herons which fledged at Cassils, Rainier and Tilley in 1964 and 1965 were banded. However, most juveniles which I saw or collected in August of these years were unbanded birds. This is good evidence of post-fledging dispersal from other colonies.

DISCUSSION

The nearest populations of Night Herons south of Alberta are in Wyoming. The presence of this species in Saskatchewan and its absence from most of Montana suggests that Night Herons invaded Alberta from Saskatchewan. If the invasion came from the East, the populations in central and southern Alberta could be disjunct. Summer observations are needed between the two known portions of the Night Heron range in Alberta (Fig. 1) to determine the nature of their distribution in this province.

I suspect that Night Herons have been present in Alberta longer than the first record in 1958 suggests. Their nocturnal habits outside the breeding season and avoidance of settled areas make the Night Herons elusive to many observers. A large colony such as Sealy found at Cassils probably took several years to reach 300 pairs of breeding birds. Exactly when the herons entered the province cannot be determined. Since there is much observation each year at Beaverhill Lake, it can be safely assumed that 1959 was the first year that Night Herons appeared there.

The region which I studied in southern Alberta was

probably unsuitable for Night Herons before the development of the irrigation system and subsequent impoundments. These factors were important in terms of food and nesting requirements of this species.

Night Herons like most other herons have catholic food habits. Their food is almost exclusively animal prey. In most parts of the Night Heron's range fish is the staple diet. However, in years when other prey items become very abundant, the herons are adaptable enough to switch temporarily to these readily available prey. Allen and Mangels (1940) stated that Night Herons in New York took Microtus pennsylvanicus almost exclusively in 1935 but relied upon fish in other years. Wetmore (1920) found birds in New Mexico eating large numbers of larval tiger salamanders (Ambystoma tigrinum).

It is obvious that the Night Herons in Alberta also were opportunistic in their feeding habits. Similar nesting requirements caused the herons and Franklin's Gulls to be associated at Cassils and Tilley. The herons took advantage of this relationship and fed gull chicks to their own nestlings. Blackbird nestlings were also taken, but to a much lesser extent. The gulls and blackbirds nested later than the Night Herons, and the lag was sufficient to produce young gulls and blackbirds at the time when the young herons were old enough to swallow these larger food items. Several heron species have been reported to eat young birds, but Bent (1926) did not include the Night Heron as one of these. Since then Peters and Burleigh (1951), Beckett (1964), and Kale (1965)

have reported ducklings and young egrets and ibises as food of Night Herons. Winterbottom (1957) in Africa found that Night Herons ate many nestling egrets.

Because they are rapidly digested, fish are underestimated in Tables IX and X. I think the herons depended largely upon fish, at least after the breeding season. By early July very few young birds were available. After the heron nestlings fledged all Night Herons left their nesting marshes and dispersed to feeding areas along irrigation ditches and lakeshores where fathead minnows (_Pimephales promelas_) and sticklebacks (_Eucalia inconstans_) were abundant.

If the herons are dependent upon fish for food, it follows that the irrigation development in southern Alberta is responsible for the presence there of Night Herons. The shallow lakes in this region cannot support fish populations, because during winter either the lakes freeze to the bottom or oxygen depletion is too severe for the fish (Keith, 1961). The sources of the fish are the Bow River and several reservoirs, chiefly Lake Newell. At Tilley the deeper water allows more fish to overwinter than at Cassils. Some did survive the winter at Cassils, for Night Herons were seen catching fish at San Francisco Lake on May 5 and 9, before the canals had been opened. Small fish usually follow the irrigation canals and ditches after they are opened in mid-May each year. Large numbers of these fish appeared at San Francisco Lake about June 7. It is certain that the herons must find other prey in the spring until fish become abundant. They probably eat more voles at this time. Nothing is known about the food

of Night Herons at Beaverhill Lake.

The fish present as a result of the irrigation system in southern Alberta provided a niche for fish-eating birds. The only possible competitors with the Night Herons were Western Grebes (*Aechmophorus occidentalis*) and Bitterns. Western Grebes nested in numbers both at Cassils and Tilley. Bitterns were common but never concentrated in numbers. I found no evidence of any competition for fish. Nestlings in broods of four developed as rapidly as those in smaller broods. However, any competition for fish may have been masked as the nestlings were fed many birds at that time. Nevertheless, throughout the season I was impressed by the abundance of fish in the areas inhabited by the herons. Food was probably not a limiting factor for any of the fish-eating birds.

As stated under Study Areas, irrigation began in 1917, and Ducks Unlimited began impounding lakes in 1938. Impoundments in the Cassils area were completed in 1944. This system of irrigation canals and impoundments changed this region of southern Alberta, making it favorable for invasion by Night Herons. Irrigation canals and ditches allowed the dispersal of fish, and the impoundments supplied nesting sites which met the requirements of the species. Large shallow bodies of water were necessary for the herons to nest well in from the shores yet in emergent vegetation. The birds concentrated their fishing activities at points where ditches emptied into lakes. Most reservoirs were unsuitable because of deep water and little emergent vegetation for nesting.

Differences in the chronology of the breeding cycle and

productivity between 1964 and 1965 are difficult to evaluate. The Night Herons nested in very different areas in terms of water depth and feeding areas in these two years. There was no evidence that the nesting birds at Tilley were the same herons which nested at Cassils the previous year. The two years were very different in terms of weather. The first year was hot and dry, with very little precipitation after mid-May, whereas in 1965, temperatures were cooler and rains frequent throughout the season. Furthermore, the 1965 spring was relatively late, as shown by spring arrivals of many bird species (Appendix II).

Cooke (1913) stated that in many different parts of this heron's range average spring arrivals were April 15 to 25. The spring arrival of Night Herons in Alberta was probably in mid-April. Considering the laying chronology at Tilley (Fig. 8), the 15 herons seen at Cassils on April 27, 1965, were probably not spring arrivals. Perhaps they were birds which had arrived late and were searching for a nesting area.

I cannot say why the Night Herons vacated the Cassils marsh after 1964. Fish and aquatic insects were still abundant there in 1965.

Allen and Mangels (1940) showed that weather greatly influenced initiation of courtship. Low temperatures and rain kept courtship activities minimal. With a sharp rise in temperature some pairs began displaying, and this stimulated many other birds to court.

In 1965 the egg-laying periods of the Night Herons lagged behind those in 1964 by about a week (Fig. 8). In 1964

temperatures were relatively high. There was little precipitation until early May, by which time most of the herons were laying or incubating. Late April in 1965 was cold with rain and sleet nearly every day. This cool and wet weather probably reduced nesting synchrony and thus prolonged the overall laying period. The lack of any laying peak in 1965 also suggests that these herons were less synchronized than those in 1964.

Perhaps the bad weather also affected the reproductive physiology of the Night Herons. Synchronization is probably produced by mutual behavioral stimulation in the nesting colony (Allen and Mangels, 1940). Without this mutual stimulation the birds may not have reached a physiological peak for reproduction. This may have caused the significant decline in initial clutch size from 1964 to 1965 (Table V).

The old growth of cattails was utilized for nest sites and nest construction. Despite heavy canopy coverage (Table I) the short vegetation was of little value as protection from avian predators. From the air the Ring-billed Gulls could easily see the Night Herons and their nests. However, nest locations over water and far from the shore reduced vulnerability to mammalian predators. Any damage to the nests which may have been done by muskrats was negligible.

Egg depredation during incubation was the major cause of the low productivity. Any potential predators such as hawks, owls, crows, and Ring-billed Gulls were mobbed by Franklin's Gulls and blackbirds. Even the Night Herons were often chased. It is obvious, however, that this mobbing did

not keep the Ring-billed Gulls away from the heron nests.

Whether or not I aided the gulls in finding the Night Heron nests cannot be stated. My presence or my beaten paths in the marshes may have attracted the gulls. I think the gulls found the heron colonies without my help. No depredation was observed during my visits to the heron nests. Gulls were flushed with the incubating herons when I arrived in the marshes. Most of the herons immediately flew to the adjacent prairie and did not return to their nests until I left the colonies. The gulls also stayed away from the heron colonies during my visits. Destroyed eggs were discovered on my arrival in the colonies and this suggests that depredation occurred prior to my arrival. At Tilley the gulls had already done some damage when the heron colony was first located by me.

The amount of depredation showed no relation to the frequency or duration of my visits. At Cassils, Colonies B and R, which contained relatively few nests and were well separated from Colony A, were not disturbed by the depredating gulls. The nests were less dense in the smaller colonies (Table II) and may not have been located by the gulls. However, the gulls did locate the Tilley replacement nests, which were also some distance from the initial nests.

Both sexes of Night Herons incubate and participate in an elaborate nest-relief ceremony. Thus one might assume that the eggs are covered continually during incubation. No attentiveness figures are available, but behavior studies (Allen and Mangels, 1940; Lowe, 1954) suggest that this assumption is true. My observations with a spotting scope

showed that the aggressive Ring-billed Gulls easily lured the herons from their nests. My field notes from May 18, 1965, stated:

> "When a gull landed on an unattended heron nest, incubating herons nearby paid no attention. When an incubating bird was harassed, it rose and chased the gull for a few yards and then returned to stand a few feet from its nest."

Although never observed, perhaps the gulls used teamwork in their depredation. When an incubating heron chases one gull, others could then attack the unprotected eggs. This technique would be effective because one of the parent Night Herons is usually away feeding while the other incubates.

Mobbing or mutual defense has never been observed among Night Herons. Allen and Mangels (1940) state that Night Herons show no hostility toward crows (Corvus spp.) unless a bird's territory is threatened. Therefore, it would seem that defense by numbers is not the reason for the colonial nesting habits of the herons. Their social nature has probably evolved for mutual stimulation of courtship activities in the breeding season.

My visits may have influenced nestling mortality in two ways. Until about three days of age and especially during the first day after hatching, nestlings are susceptible to heat prostration. A few cases of such mortality did occur during my visits. Secondly, the scattering of older nestlings throughout the nesting areas may have increased their mortality. However, McClure et al. (1959) stated that younger nestlings from one brood often joined another, apparently without difficulty. In addition, mortality among older nestlings remained constant at a low level (Fig.10). I concluded that

my visits did not increase mortality significantly.

Drowning appeared to be the major cause of nestling mortality in 1964, and gulls took most of the nestlings in 1965. C. G. Hampson (pers. comm.) also found drowning to be the most important cause of mortality at Beaverhill Lake in 1960. There was no indication during my study that starvation was a mortality factor. None of the dead nestlings showed excessive weight loss or emaciation.

I found only two cases of mortality after fledging. An immature (one year old) female was found dead at Tilley on June 7, 1965. The stomach was empty and no injuries were apparent. The bird did not appear to have bred as the ovary contained only very small pre-ovulatory follicles. On May 4, 1964, an adult male was found dead at Cassils. Again the stomach was empty, and the pectoral muscles showed extreme atrophy.

Gross (1923) and McClure et al. (1959) presented growth data for Night Herons. Gross showed averages of several measurements taken from only two birds. McClure et al. measured the third primary and tarsus of many nestlings. They showed that a great deal of individual variation in development occurred and that accurate aging could not be accomplished by these measurements. The growth variations were thought to be caused by competition for food among siblings and environmental factors. At Cassils no broods of five or more nestlings were raised to fledging. Possible competition among siblings was only evidenced in broods larger than four. Owen (1955) observed that Common Herons (Ardea cinerea) fledged maximum broods of four. Comparisons of growth

rates within different broods showed no consistent slowing of growth in larger broods. This suggests that food was not a limiting factor, at least in 1964 when most of the growth measurements were taken.

McClure's growth data are difficult to compare with mine. However, the Cassils nestlings developed consistently faster than did nestlings from Massachusetts (Gross, 1923) or from Japan (McClure *et al*., 1959).

Hickey (1952) published a life table for Black-crowned Night Herons. The data for his table were secured from 141 recoveries of banded birds. He showed that 61% of the Night Herons die in their first year after fledging and that the survivors subsequently suffer 31% annual mortality. Table XI was constructed using a hypothetical population of 10 immatures and 90 older Night Herons (subadults and adults). The purpose was to test the adequacy of the productivity of 1.08 fledged young per breeding pair at Cassils in 1964 (Table VII). I assumed that no immatures breed and that all older Night Herons do breed. The latter assumption probably gives the herons an unjustified advantage.

It can be seen that this hypothetical population of Night Herons would gradually decline and would die out after about 20 years. Thus, an average productivity of 1.08 fledged young per pair is insufficient to maintain a population of Night Herons. I calculated that the average productivity over several years must be somewhat greater than 2.0 young per pair in order to maintain population numbers.

Table XI. Hypothetical Night Heron population dynamics using the productivity at Cassils in 1964 and Hickey's (1952) mortality figures. Year intervals begin on May 1.

Interval In Years	Breeding Birds		Juveniles Produced		Immatures		Total at End of Interval
0- 1	-$^+$	(90)*	-$^\#$	(10)*	-$^+$	- *	100
1- 2	90	(62)	49	(19)	10	(7)	88
2- 3	69	(48)	37	(14)	19	(13)	75
3- 4	61	(42)	32	(12)	14	(10)	64
4- 5	52	(36)	28	(11)	12	(8)	55
5- 6	44	(30)	24	(9)	11	(8)	47
6- 7	38	(26)	21	(8)	9	(6)	40
7- 8	32	(22)	17	(7)	8	(6)	35
8- 9	28	(19)	15	(6)	7	(5)	30
9-10	24	(17)	13	(5)	6	(4)	26
10-11	21	(15)	11	(4)	5	(3)	22

$^+$ number of herons present at beginning of interval

* number of herons surviving at end of interval

$^\#$ number of herons produced during interval

Nesting success was low in the colonies studied. That there was some degree of production in other colonies was evident through sightings of several unbanded juvenile Night Herons in August and September of both years. These birds were the result of post-fledging dispersal from other colonies, possibly those farther north such as the one at Beaverhill Lake. C. G. Hampson (pers. comm.) found an average of 4.61 eggs (S.D.± 1.01) in 33 clutches at Beaverhill Lake in 1959 and 1960. This average was significantly higher than the average of 3.96 eggs at Cassils in 1964.

LITERATURE CITED

Allen, R. P., and F. P. Mangels. 1940. Studies of the nesting behavior of the Black-crowned Night Heron. Proc. Linn. Soc. N. Y., 50-51: 1-28.

American Fisheries Society. 1960. A list of common and scientific names of fishes from the United States and Canada. Spec. Publ. No. 2. Waverly Press Inc., Baltimore, Md. 102 pp.

American Ornithologists' Union. 1957. Check-list of North American birds. Fifth Edition. Lord Baltimore Press, Baltimore, Md. 691 pp.

Beckett, T. A. 1964. Black-crowned Night Heron feeding behavior. Chat, 28: 93-94. From abstract in Auk, 82: 533.

Bent, A. C. 1926. Life histories of North American marsh birds. U. S. Nat. Mus. Bull. 135. 392 pp.

Cooke, W. W. 1913. Distribution and migration of North American herons and their allies. U. S. Dept. Agr. Biol. Survey, Bull. 45. 70 pp.

Coupland, R. T. 1950. Ecology of mixed prairie in Canada. Ecol. Monographs, 20: 271-315.

Godfrey, W. E. 1950. Birds of the Cypress Hills and Flotten Lake regions, Saskatchewan. Nat. Mus. Can., Biol. Ser. 40, Bull. 120. 96 pp.

Gross, A. O. 1923. The Black-crowned Night Heron (*Nycticorax nycticorax naevius*) of Sandy Neck. Auk, 40: 1-30; 191-214.

Hickey, J. J. 1952. Survival studies of banded birds. U. S. Fish & Wildl. Service, Spec. Sci. Rept.: Wildl. No. 15. 177 pp.

Kale, H. W., II. 1965. Nesting predation by herons in a Georgia heronry. Oriole, 30: 69-70. From abstract in Auk, 82: 673.

Keith, L. B. 1961. A study of waterfowl ecology on small impoundments in southeastern Alberta. Wildl. Monographs, No. 6. 88 pp.

Logier, E. B. S., and G. C. Toner. 1961. Check list of the amphibians and reptiles of Canada and Alaska. Contrib. No. 53, Royal Ontario Mus. 92 pp.

Lowe, F. A. 1954. The heron. Collins, London. 177 pp.

McClure, H. E., M. Yoshii, Y. Okada, and W. F. Scherer. 1959. A method for determining age of nestling herons in Japan. Condor, 61: 30-37.

Moreau, R. E., and W. M. Moreau. 1940. Incubation and fledging periods of African birds. Auk, 57: 313-325.

Moss, E. H. 1959. Flora of Alberta. Univ. of Toronto Press. 546 pp.

Noble, G. K., and M. Wurm. 1942. Further analysis of the social behavior of the Black-crowned Night Heron. Auk, 59: 205-224.

Noble, G. K., M. Wurm, and A. Schmidt. 1938. Social behavior of the Black-crowned Night Heron. Auk, 55: 7-40.

Owen, D. F. 1955. The food of the heron (Ardea cinerea) in the breeding season. Ibis, 97: 276-295.

Peters, H. S., and T. D. Burleigh. 1951. The birds of Newfoundland. Dept. Nat. Resources, Prov. of Newfoundland. 431 pp.

Rearden, J. D. 1951. Identification of waterfowl nest predators. J. Wildl. Mgmt., 15: 386-395.

Salt, W. R. 1961. Recent additions to the avifauna of Alberta. Auk, 78: 427-428.

Salt, W. R., and A. L. Wilk. 1958. The birds of Alberta. Hamly Press Ltd., Edmonton, Alta. 511 pp.

Saunders, A. A. 1921. A distributional list of the birds of Montana. Pacific Coast Avifauna No. 14. Cooper Ornith. Club, Berkeley, Calif. 194 pp.

Seton, E. T. 1891. The birds of Manitoba. Proc. Nat. Mus., Vol. XIII: 457-643.

Welty, J. C. 1962. The life of birds. W. B. Saunders Co., Philadelphia, Pa. 546 pp.

Wetmore, A. 1920. Observations on the habits of birds at Lake Burford, New Mexico. Auk, 37: 221-247; 393-412.

Winterbottom, J. M. 1957. Some African herons. African Wildl., Vol. II (2): 100-105.

APPENDIX I

Average measurements of nestling Night Herons. Weight in grams, others in centimeters. Sample sizes in parentheses.

Age in Days	Weight	Culmen	Wing Arc	Tarsometatarsus
0	35 (47)	1.48	1.52	1.97 (61)
1	48 (32)	1.59	1.65	2.15 (42)
2	63 (33)	1.77	1.83	2.43 (45)
3	84 (26)	1.97	2.10	2.80 (33)
4	115 (23)	2.29	2.42	3.18 (42)
5	147 (31)	2.57	2.97	3.65 (41)
6	182 (36)	2.80	3.47	4.05 (49)
7	219 (25)	3.07	4.16	4.54 (38)
8	256 (18)	3.27	4.90	4.95 (43)
9	309 (17)	3.55	5.89	5.45 (31)
10	321 (13)	3.68	6.34	5.69 (33)
11	394 (16)	3.93	7.76	6.29 (34)
12	397 (23)	4.06	8.12	6.34 (48)
13	458 (8)	4.25	9.45	6.74 (26)
14	477 (10)	4.43	10.46	7.07 (24)
15	513 (2)	4.67	11.69	7.48 (19)
16	538 (7)	4.81	11.99	7.49 (17)
17	468 (5)	4.83	13.55	7.84 (19)
18	529 (9)	4.93	13.75	7.79 (33)
19	581 (4)	5.10	16.02	8.20 (10)
20	544 (4)	5.22	16.05	8.30 (13)
21	582 (6)	5.32	16.36	8.36 (8)
22	650 (2)	5.44	18.60	8.75 (10)
23	558 (3)	5.20	18.10	8.43 (9)
24	620 (2)	5.67	18.67	8.80 (3)
25	513 (2)	5.50	18.43	8.44 (4)
26	625 (1)	5.43	21.25	8.83 (2)
27	687 (2)	5.83	22.60	9.13 (3)
28	650 (1)	5.75	22.40	9.05 (2)
29	676 (3)	5.83	23.90	8.94 (3)
31	590 (1)	5.75	25.30	8.90 (1)
33	750 (1)	5.85	25.50	8.80 (1)
35	775 (2)	6.23	27.25	9.53 (2)
37	500 (1)	5.80	25.00	9.10 (1)
40	740 (1)*	6.20	28.60	9.30 (1)*
58	550 (1)	6.60	30.50	9.40 (1)

* fledged

APPENDIX II

First spring sightings of transient and summer resident birds in southern Alberta, 1964 and 1965. Most observations before April 24 were made at Beaverhill Lake. Observations began April 4 and April 8.

Species	Common Name	1964	1965
Podiceps grisegena	Red-necked Grebe	April 26	April 24
Podiceps auritus	Horned Grebe	May 3	April 26
Podiceps caspicus	Eared Grebe	April 26	April 24
Aechmophorus occidentalis	Western Grebe	May 3	April 24
Podilymbus podiceps	Pied-billed Grebe	May 19	May 21
Pelecanus erythrorhynchos	White Pelican	-	May 4
Phalacrocorax auritus	Double-cr. Cormorant	-	May 14
Ardea herodias	Great Blue Heron	April 19	April 18
Nycticorax nycticorax	Night Heron	<April 24	-
Botaurus lentiginosus	American Bittern	May 11	May 13
Olor columbianus	Whistling Swan	April 4	April 16
Branta canadensis	Canada Goose	April 4	April 13
Anas platyrhynchos	Mallard	April 4	April 8
Anas strepera	Gadwall	April 19	April 24
Anas acuta	Pintail	April 4	April 10
Anas carolinensis	Gr.-winged Teal	April 19	April 18
Anas discors	Bl.-winged Teal	April 12	April 24
Anas cyanoptera	Cinnamon Teal	May 22	-
Mareca americana	American Widgeon	April 4	April 16
Aythya americana	Redhead	April 24	April 24
Aythya valisineria	Canvasback	April 24	April 24
Aythya affinis	Lesser Scaup	April 12	April 24
Bucephala clangula	Common Goldeneye	April 12	April 8
Bucephala albeola	Bufflehead	April 19	April 24
Melanitta deglandi	Wh.-winged Scoter	-	May 15
Oxyura jamaicensis	Ruddy Duck	April 26	April 25

Appendix II (continued)

Species	Common Name	1964	1965
Mergus merganser	Common Merganser	April 10	April 8
Mergus serrator	Red-br. Merganser	April 19	April 24
Buteo jamaicensis	Red-tailed Hawk	April 10	April 8
Buteo swainsoni	Swainson's Hawk	April 24	May 1
Buteo lagopus	Rough-legged Hawk	April 4	April 18
Buteo regalis	Ferruginous Hawk	-	May 1
Circus cyaneus	Marsh Hawk	April 4	April 8
Falco sparverius	Sparrow Hawk	April 10	April 8
Porzana carolina	Sora Rail	May 14	May 19
Fulica americana	Coot	April 19	April 23
Charadrius semipalmatus	Semipalmated Plover	April 26	May 10
Charadrius vociferus	Killdeer	April 4	April 8
Squatarola squatarola	B.-bellied Plover	May 11	May 15
Capella gallinago	Common Snipe	May 3	May 6
Numenius americanus	Long-billed Curlew	April 24	April 24
Bartramia longicauda	Upland Plover	-	May 24
Actitis macularia	Spotted Sandpiper	May 24	May 22
Tringa solitaria	Solitary Sandpiper	May 7	May 6
Catoptrophorus semipalmatus	Willet	May 3	April 24
Totanus melanoleucus	Greater Yellowlegs	April 24	-
Totanus flavipes	Lesser Yellowlegs	April 24	May 4
Erolia melanotos	Pectoral Sandpiper	April 26	-
Erolia bairdii	Baird's Sandpiper	-	May 10
Erolia minutilla	Least Sandpiper	May 12	May 10
Limnodromus spp.	Dowitchers	May 3	May 6
Ereunetes pusillus	Semip. Sandpiper	May 3	May 10
Limosa fedoa	Marbled Godwit	May 3	April 24
Recurvirostra americana	Avocet	April 26	April 23
Steganopus tricolor	Wilson's Phalarope	May 3	May 9
Lobipes lobatus	Northern Phalarope	-	May 19
Larus californicus	California Gull	April 4	April 8
Larus delawarensis	Ring-billed Gull	April 4	April 8
Larus pipixcan	Franklin's Gull	April 19	April 24

Appendix II (continued)

Species	Common Name	1964	1965
Sterna hirundo	Common Tern	May 6	May 2
Chlidonias niger	Black Tern	May 19	May 13
Zenaidura macroura	Mourning Dove	May 15	April 27
Speotyto cunicularia	Burrowing Owl	-	April 8
Asio flammeus	Short-eared Owl	April 4	April 30
Chordeiles minor	Nighthawk	-	May 19
Tyrannus tyrannus	Eastern Kingbird	May 17	May 14
Tyrannus verticalis	Western Kingbird	May 25	May 26
Sayornis saya	Say's Phoebe	May 7	May 10
Empidonax minimus	Least Flycatcher	May 19	May 22
Contopus sordidulus	Western Wood Pewee	-	June 1
Nuttallornis borealis	Olive-sided Flycatcher	May 6	May 22
Eremophila alpestris	Horned Lark	April 4	April 8
Iridoprocne bicolor	Tree Swallow	-	May 6
Riparia riparia	Bank Swallow	May 2	May 4
Stelgidopteryx ruficollis	Rough-winged Swallow	-	May 6
Hirundo rustica	Barn Swallow	May 7	May 6
Petrochelidon pyrrhonota	Cliff Swallow	May 2	May 4
Corvus brachyrhynchos	Common Crow	April 4	April 8
Sitta canadensis	Red-br. Nuthatch	April 24	May 7
Troglodytes aedon	House Wren	-	May 15
Telmatodytes palustris	Long-billed Marsh Wren	May 11	May 14
Dumetella carolinensis	Catbird	-	June 1
Toxostoma rufum	Brown Thrasher	May 14	May 16
Turdus migratorius	Robin	April 4	April 8
Hylocichla guttata	Hermit Thrush	-	May 6
Hylocichla ustulata	Swainson's Thrush	May 6	May 6
Hylocichla fuscescens	Veery	-	June 1
Myadestes townsendi	Townsend's Solitaire	April 24	April 30
Anthus spinoletta	Water Pipit	April 24	-
Lanius excubitor	Northern Shrike	April 4	April 8
Lanius ludovicianus	Loggerhead Shrike	April 24	May 3
Sturnus vulgaris	Starling	April 4	April 8

Appendix II (continued)

Species	Common Name	1964	1965
Vireo olivaceus	Red-eyed Vireo	-	May 20
Vireo philadelphicus	Philadelphia Vireo	-	May 6
Vireo gilvus	Warbling Vireo	May 12	May 15
Vermivora peregrina	Tennessee Warbler	-	May 15
Vermivora celata	Orange-cr. Warbler	May 12	May 15
Dendroica petechia	Yellow Warbler	May 17	May 14
Dendroica coronata	Myrtle Warbler	April 26	May 1
Dendroica castanea	Bay-breasted Warbler	-	May 20
Dendroica striata	Blackpoll Warbler	May 13	May 18
Seiurus noveboracensis	Northern Waterthrush	-	May 15
Oporornis philadelphia	Mourning Warbler	-	May 20
Geothlypis trichas	Yellowthroat	May 13	May 19
Wilsonia pusilla	Wilson's Warbler	-	May 16
Setophaga ruticilla	American Redstart	-	May 15
Sturnella neglecta	Western Meadowlark	April 4	April 8
Xanthocephalus xanthocephalus	Y.-headed Blackbird	April 24	April 24
Agelaius phoeniceus	R.-winged Blackbird	April 12	April 8
Icterus galbula	Baltimore Oriole	May 17	May 18
Euphagus cyanocephalus	Brewer's Blackbird	April 24	May 2
Quiscalus quiscula	Common Grackle	April 26	May 5
Molothrus ater	Cowbird	May 2	May 4
Piranga ludoviciana	Western Tanager	-	May 24
Spinus tristis	American Goldfinch	May 25	May 26
Pipilo erythropthalmus	Rufous-sided Towhee	-	May 18
Calamospiza melanocorys	Lark Bunting	May 28	May 21
Passerculus sandwichensis	Savannah Sparrow	April 24	April 27
Pooecetes gramineus	Vesper Sparrow	April 24	May 2
Junco hyemalis	Slate-colored Junco	April 12	April 13
Spizella passerina	Chipping Sparrow	May 12	May 12
Spizella pallida	Clay-colored Sparrow	May 15	May 12
Zonotrichia querula	Harris' Sparrow	April 4	-
Zonotrichia leucophrys	White-crowned Sparrow	May 2	April 30
Melospiza melodia	Song Sparrow	April 26	May 5

Appendix II (continued)

Species	Common Name	1964	1965
Rhynchophanes mccownii	McCown's Longspur	May 8	-
Calcarius lapponicus	Lapland Longspur	April 24	April 24
Calcarius ornatus	Chestnut-collared Longspur	April 24	April 24
Plectrophenax nivalis	Snow Bunting	April 4	April 8

(Names follow the A.O.U. Check-list, 1957)

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